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Vol. XXVIII.
No. 706.

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JUNE 5, 1891.

[Registered at G.P.O. as a Newspaper.]

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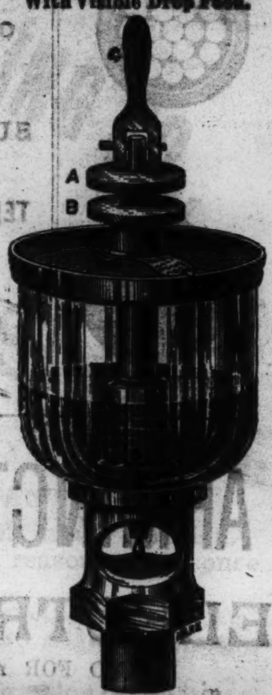

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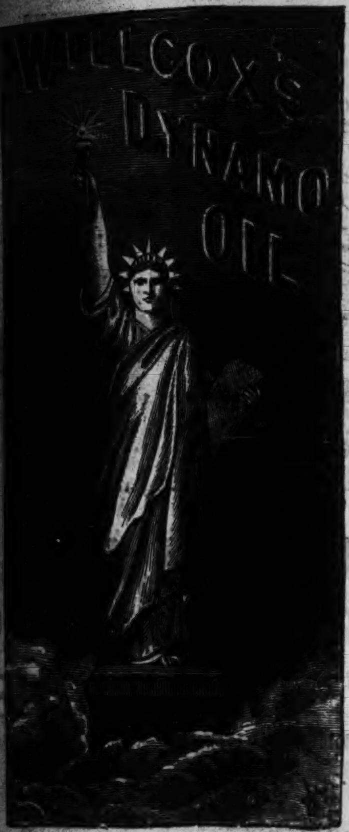

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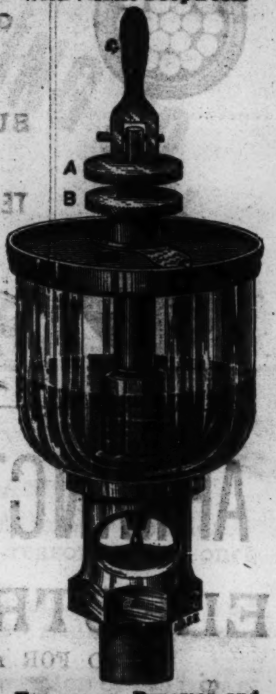

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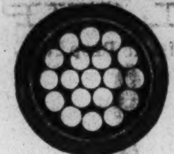

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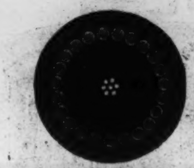

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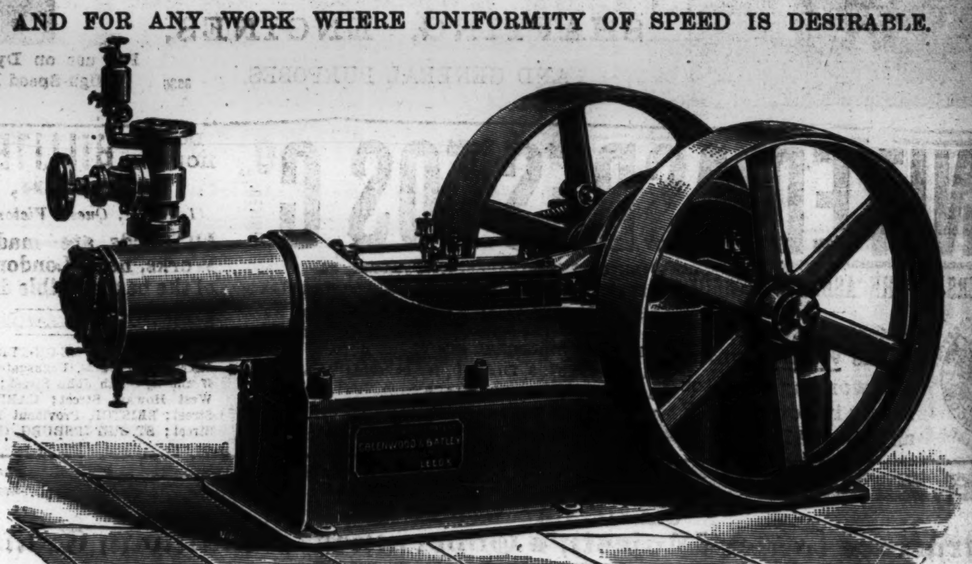

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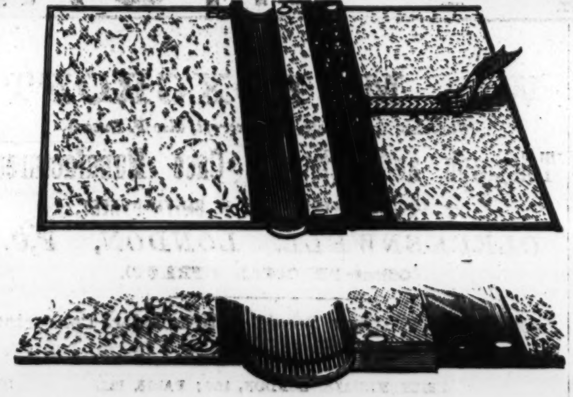

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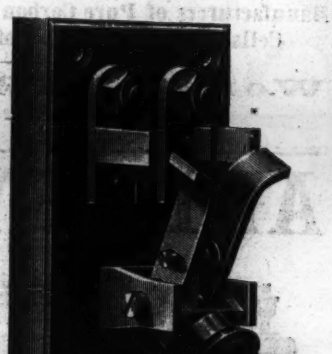

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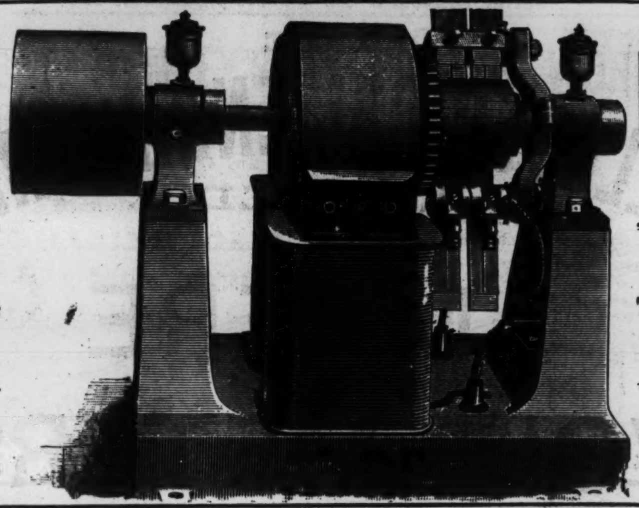

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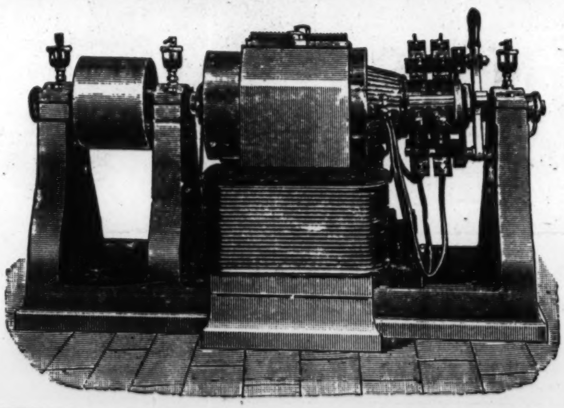

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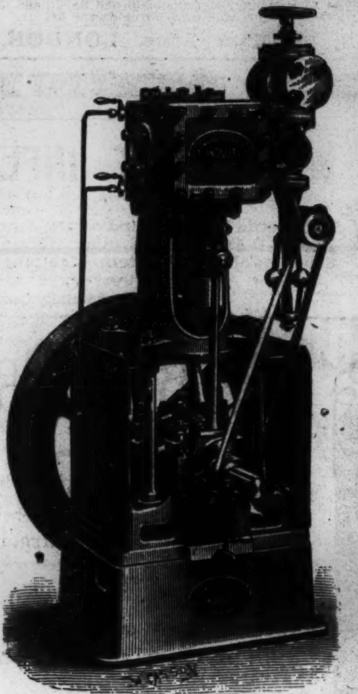

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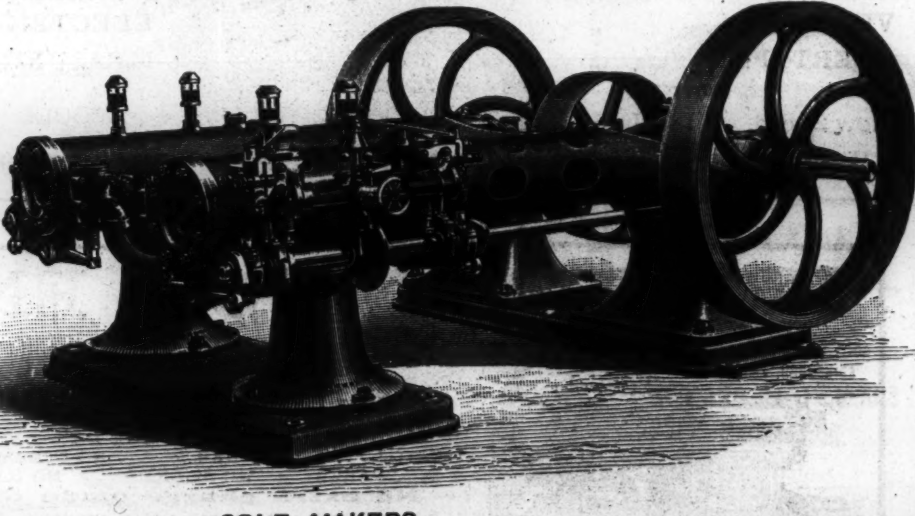

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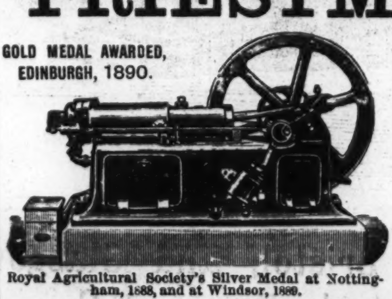

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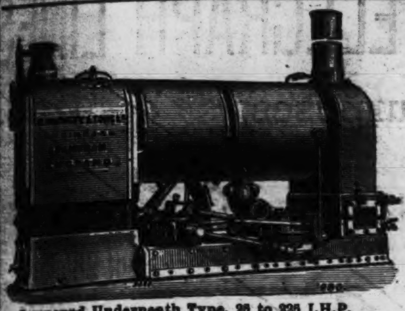

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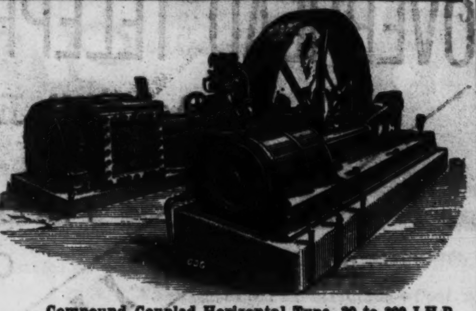

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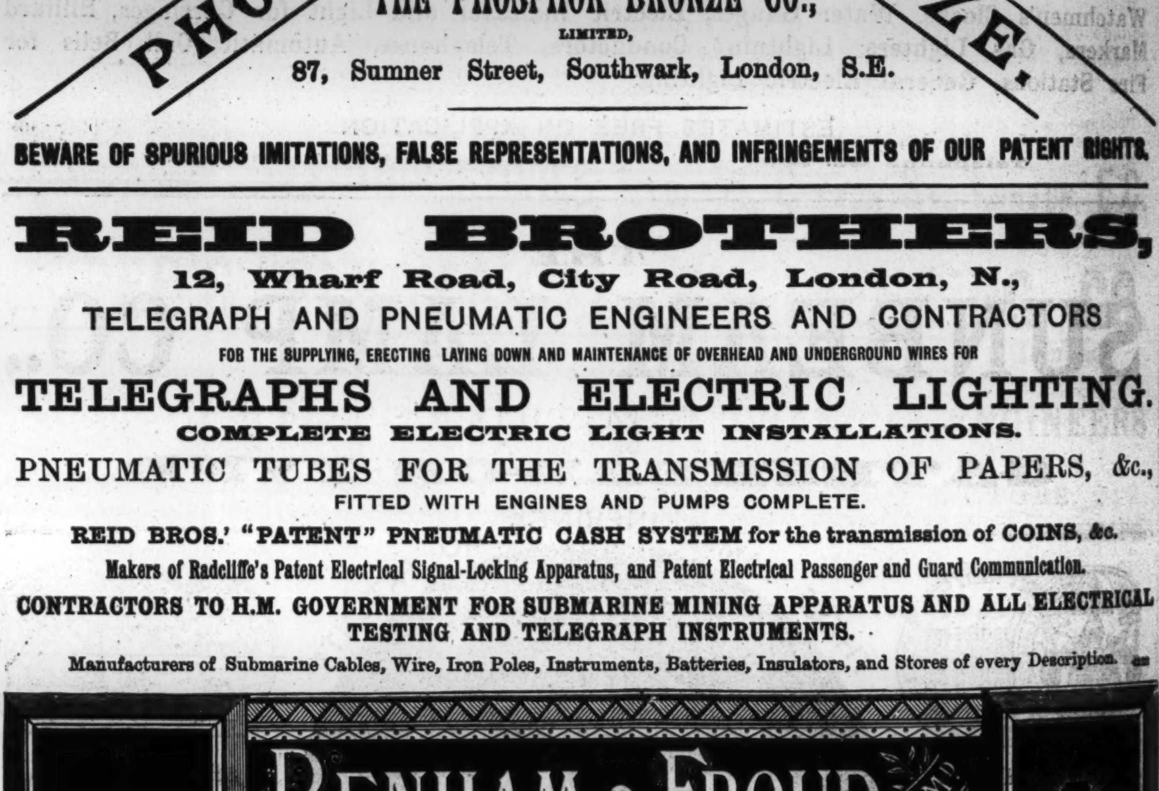

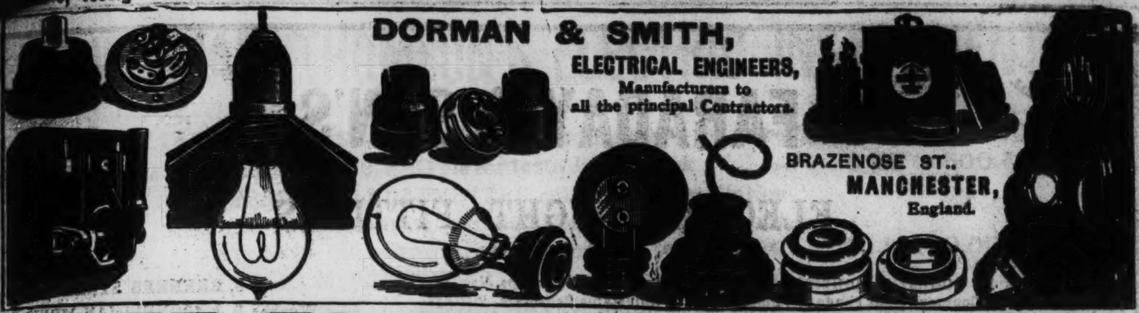

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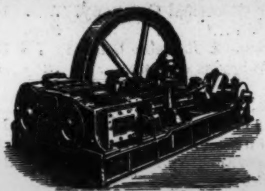

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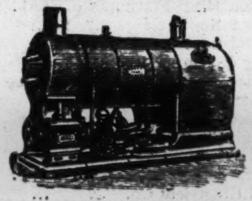

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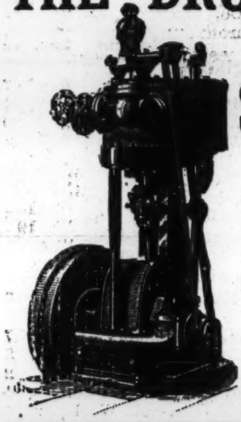

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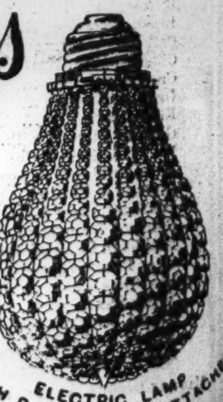

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4444

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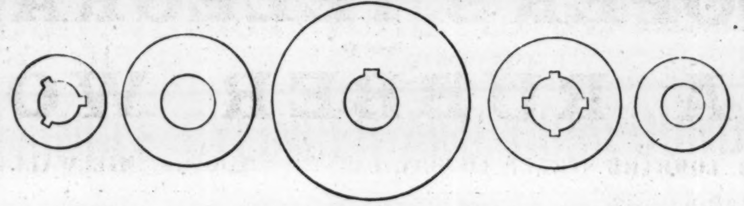

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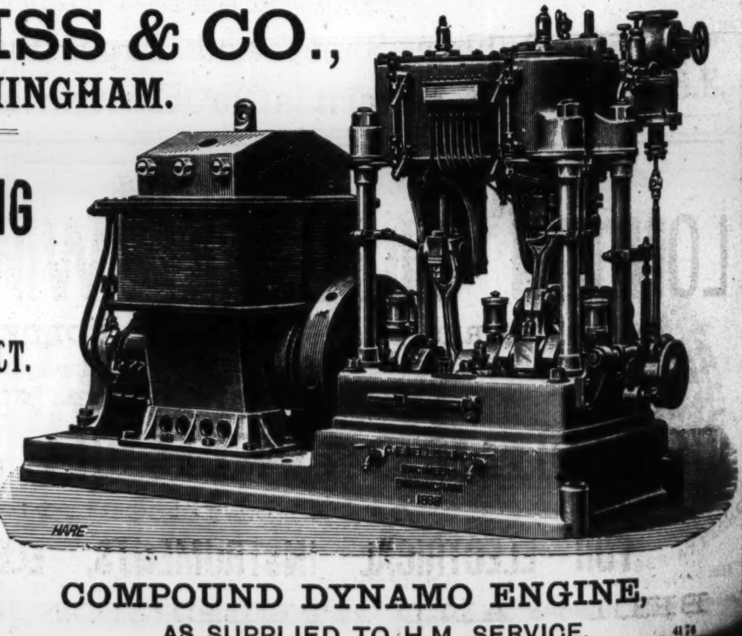

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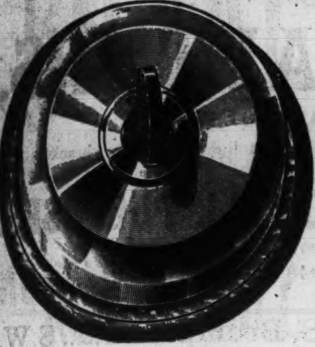

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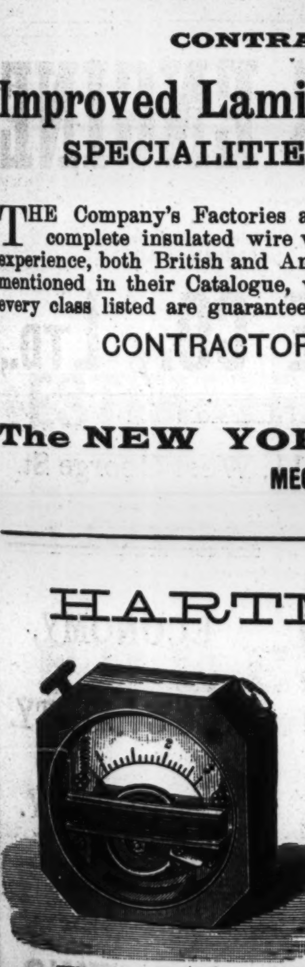

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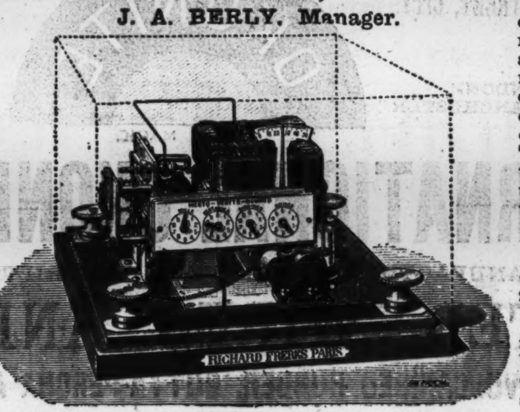

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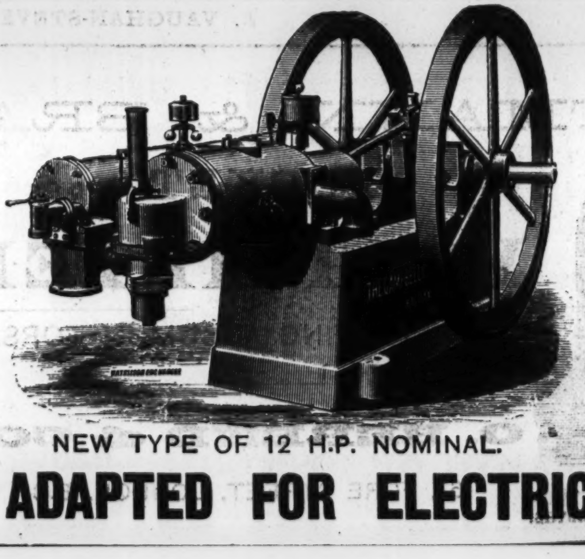

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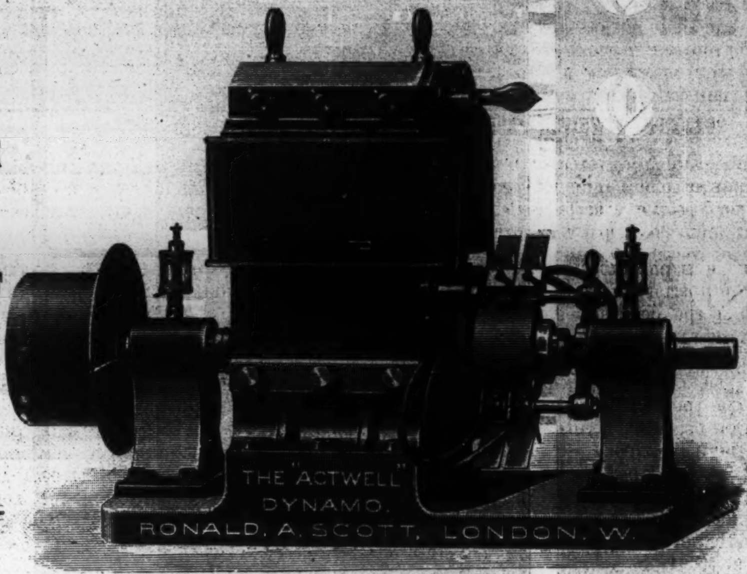
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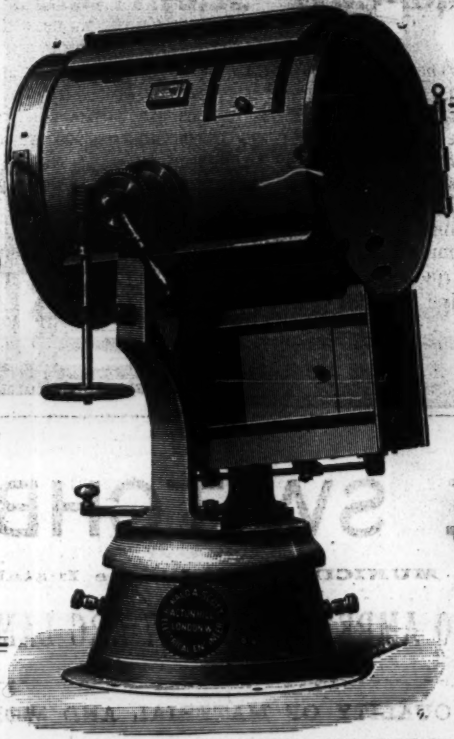

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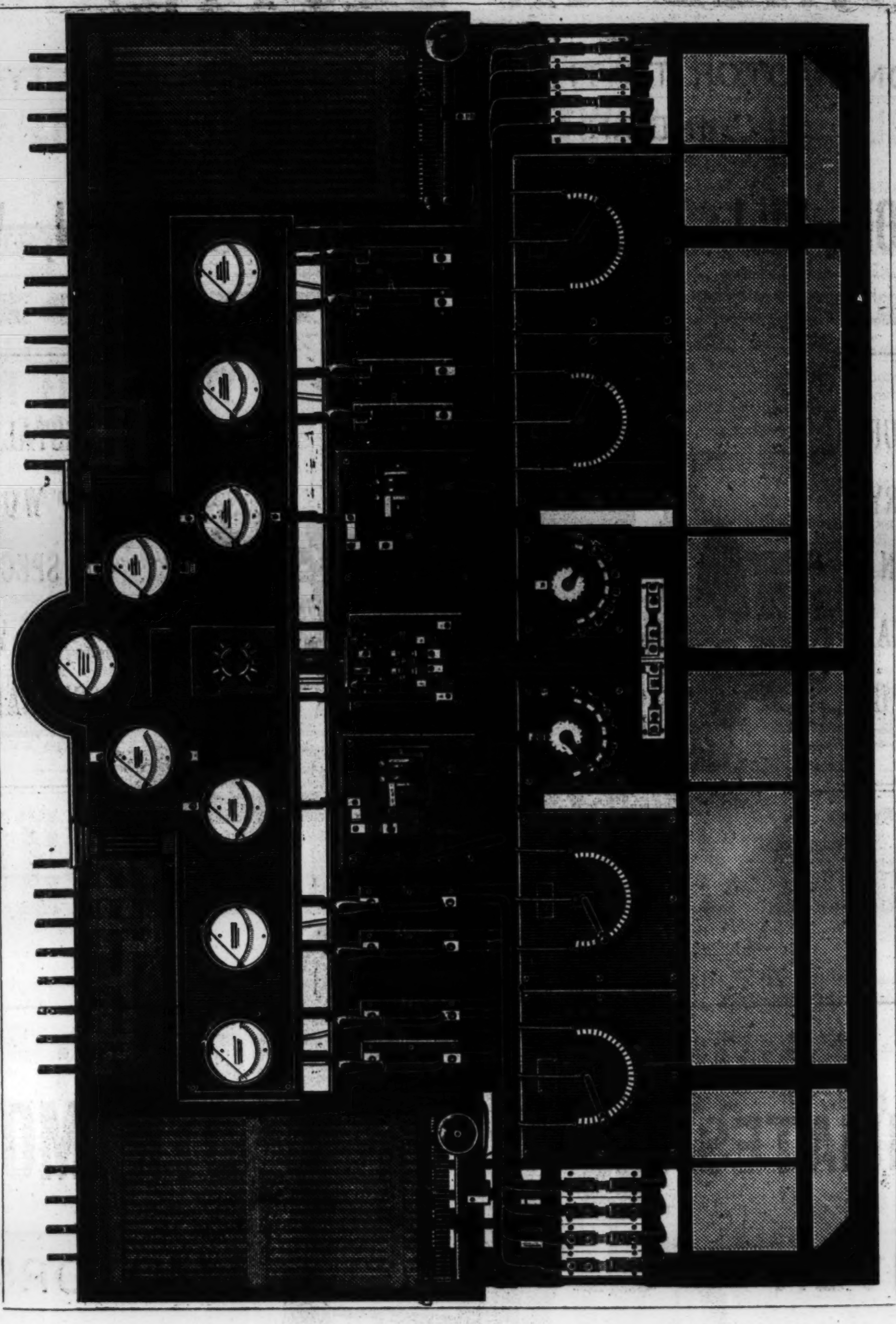

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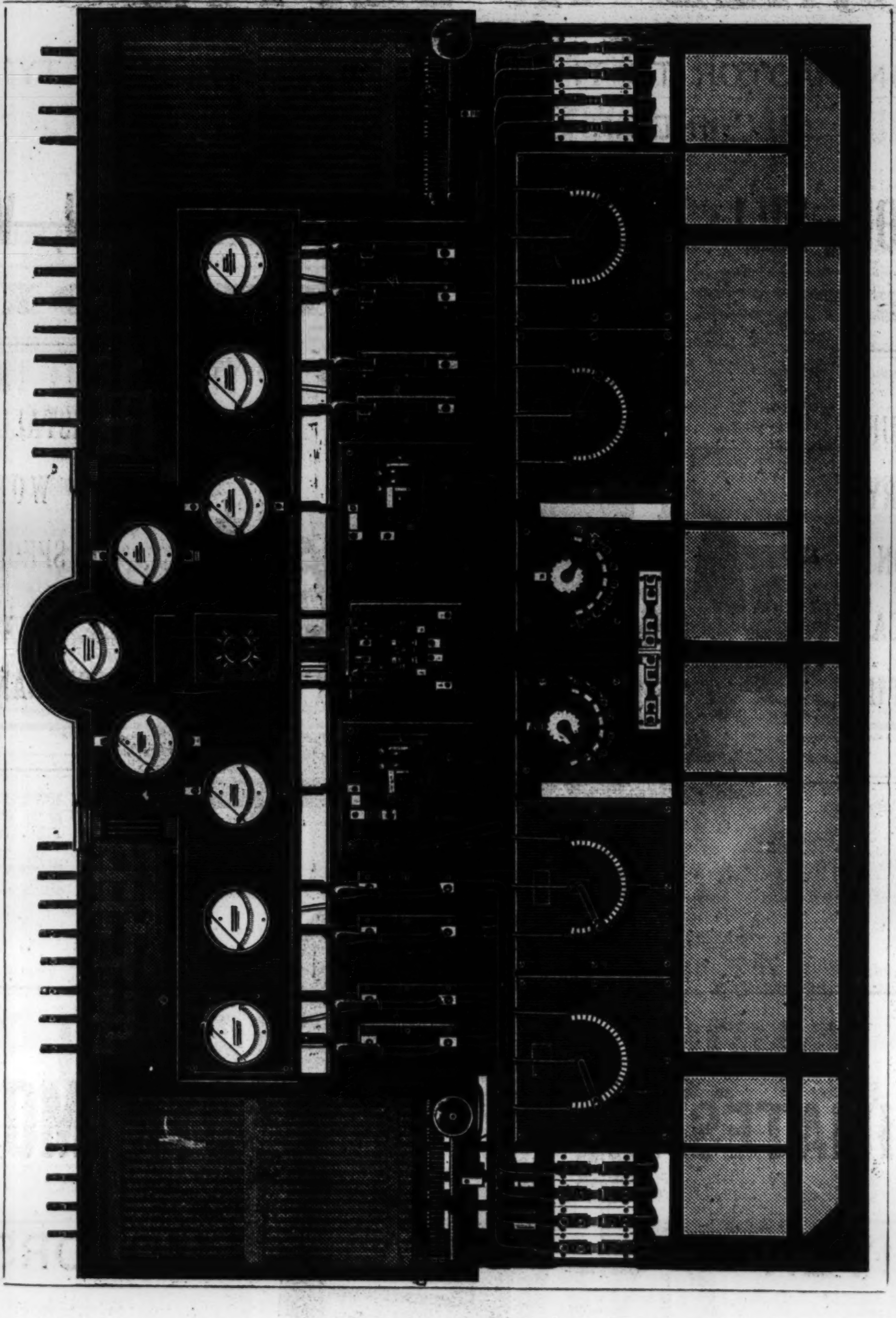

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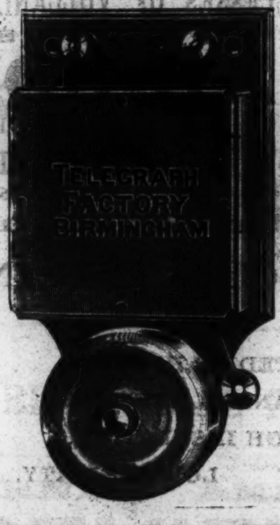

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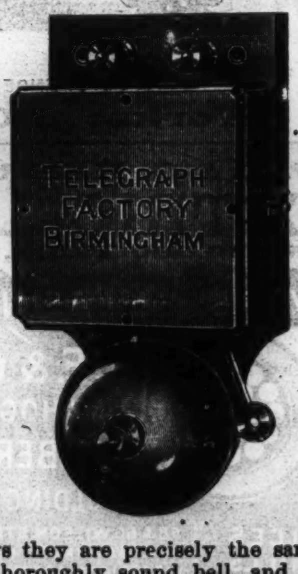

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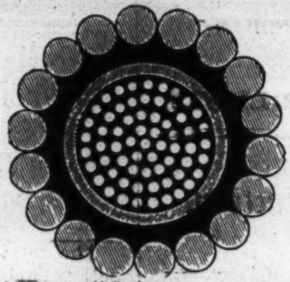

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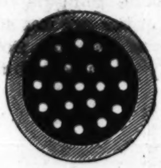

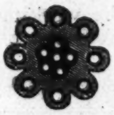

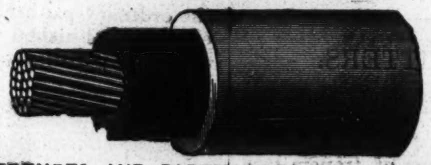

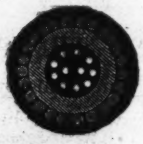

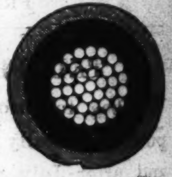

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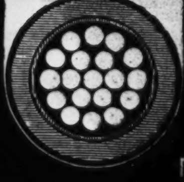

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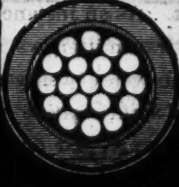

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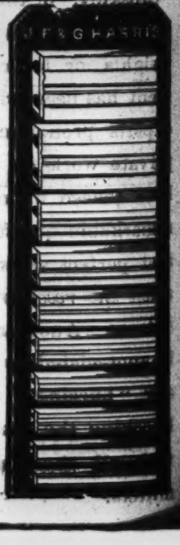

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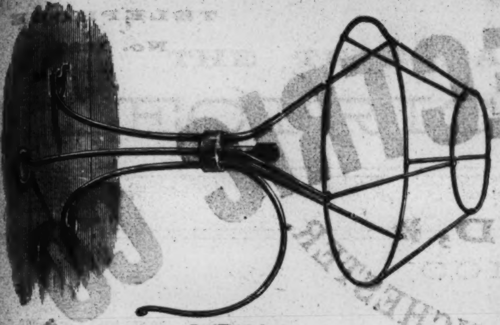

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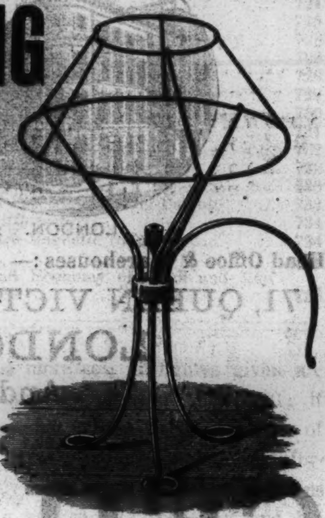

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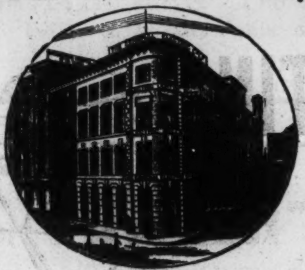
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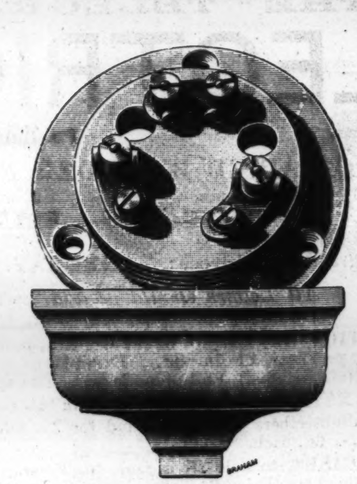

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ELECTRICAL REVIEW.

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THE ELMORE COMPANIES.

THE *Financial News* of May 27th contained a leading article on the Elmore Companies. It is a curious mixture of statements, opinions, and suppositions. They alternate in suitable order, but, for convenience of summarising, we have sorted them out and placed together kindred elements.

There is a leading *motif* which is noticeable throughout, and finds definite expression in the *finale*—the shares at the present quotation are much below their real value. There is no new information except that Mr. W. Elmore is now in charge of the works (*vice* Messrs. A. and S. Elmore, whose inexperience our contemporary previously adverted to). The merits of the process are reiterated in the terms with which we have been made so familiar from the time of the issue of the prospectuses—tubes of extraordinary quality have been turned out; the company claims they are of exceptional strength. The opinions of interested persons are quoted with satisfaction—Mr. Elmore himself is confident that the process can be made a commercial success; on the part of the directors there is unquestionably a strong and genuine faith in the financial future; M. Secrétan states that all the promises may now be considered as fulfilled, and that the manufacture is as successful as it can possibly be. The output of the works (at some future time), the supposed demand (when the output is attained), and the consequent hopeful prospects, all find their place in the article in the usual way. Caution and candour are not absent—the invention had not hitherto emerged much beyond the stage of experiment, and it ought to be frankly stated that the companies have met with a great deal of adverse criticism. But the article is stronger in the conditional than the other elements. If ifs and ands were pots and pans wrought straight from Chili bars untouched by hands, the Elmore Company would find plenty of business in supplying the requirements of their financial advocate—if the data given is sound and reasonable it is difficult to discover any fair ground for pessimistic views; if M. Secrétan finds a sale for 100 tons a week it is certain the shares are too low; if the English undertaking is promising the French one should be more so; if figures given are correct they show an annual net profit of £224,000; if very handsome dividends are not gained the expectations of the management must be greatly at fault; unless the information supplied be greatly exaggerated certain criticisms will have to be withdrawn, and so on. The cost and the profit are indefinite, of course—it is said that 1d. per lb. of copper employed covers the cost of production; it is claimed by the company's officials that the 20 tons of tubing to be produced weekly can be disposed of at an average net profit of 2s. per lb. Of the Wire company, we are told that their works are estimated to turn out 100 to 200 tons every week, and the article would be incomplete without the reiteration that the wire has a conductivity of 4·40 per cent. above Dr. Matthiessen's standard; and some significance may surely be claimed for the fact that a Birmingham syndicate has given considerable orders for a year in advance.

The *Financial News* has had to go as far as New York to learn that some technical objections have been raised to the process, and that some "suspicions" exist that there is too much of the "stock jobbing" element in connection with the concerns. It was only "a few weeks ago" that this suspicion was given voice to, and then by the *Engineering and Mining Journal* of New York. We are grateful to our transatlantic contemporary for the expression of its views; whilst we cannot but regret that in professing to combat them, the *Financial News* should have taken the opportunity of publishing an article of a most misleading character. The *Financial News*, in quoting the *Engineering and Mining Journal*, contrasts its views with facts which are vouched for by the officials of the English company. The *Engineering and Mining Journal* had stated that the deposit is of a foliated character, and that it exfoliates upon heating even to a very moderate degree, and, further, that it was very openly charged, that the process was being worked as a stock speculation rather than as an industrial investment. It seems to the *Financial News* that the best answer to this is to be found in the fact that repeat orders continue to flow into the Leeds works, and if the tubes are bad, it asks, or if the deposit show the defect as alleged, why on earth do customers continue to purchase them? The stock jobbing question the *Financial News* thinks a very insignificant one beside that of the merits of the invention and its commercial possibilities, and these two questions are apparently settled by the claims of the Leeds management that the increasing demand proves the one, and the difference between cost of production and selling price the other.

There being no better answer than the "repeat orders" we are afraid the outlook is not promising. There is nothing new about that answer. We have been familiar with it for some time. It is quite useless unless we are told the amount of the orders and the purpose for which the articles are used. Some information as to where they come from would also be desirable. If a customer buys sixpennyworth of Elmore copper and comes back for threepennyworth more it is a "repeat order." We are sorry to say it, but, in reference to the Elmore concerns, generalities will not do. We must have something definite and tangible. True, the extent of the repeat orders is implied to be large, because they "flow in," but we would still like to know something about the nature and extent of the flood, and be able to form some opinion as to the possibility of an ebb.

The article in question is an extraordinary one, and serves to add strength to the "suspicion" of the stock-jobbing question which is so "insignificant." The responsibility for the article is divided between those who supplied the information and the editor of the *Financial News*. We are saved the necessity of speculating as to where the information was obtained by the definite statement that it was supplied by persons, not merely familiar with the process, but engaged in working it.

In our correspondence columns we have been told that on the subject of the Elmore Companies the officials' mouths were closed by the directors, who in their wisdom had declined to allow any information to be given, and in our issue of April 17th, we remarked that "curiously enough there is seldom any restriction on statements of an indefinite but favourable character from the Elmore interest." The *Financial News* article is another instance of the truth of that remark.

We cannot expect the *Financial News* to be well informed on the technical questions, to know that the economy of production, considered on commercial grounds, is a fallacy which has been exposed over and over again in our columns; to know that a percentage of conductivity over Matthiessen's standard is common to any copper manufacturer who wishes to attain it, but we should expect the editor of a financial journal to see the financial and commercial absurdities jumbled together in his article. Wherein is the use of quoting estimates, even under a saving clause of non-commitment, which show an annual net profit of £224,000 on a capital of £140,000? The total is arrived at by taking the output of twenty tons per week, which will "shortly" be obtained, multiplying it by the moderate number of 50 weeks to a year, and assuming a net profit of 2s. per lb. for the lot. This basis is either a reasonable, well-considered one, or it is mere wild guess-work. In the former event why cut off the first figure and draw attention to the fact that even £24,000 would be very satisfactory? In the latter event why not alter one or other factor so as to put a seventh figure on the left hand side and then make allowances by cutting it out again? Is the *Financial News* aware of any business which makes a profit of two shillings on an expenditure of one penny without inciting competition which results in a speedy reduction to more modest dimensions? Should the editor of a financial journal have any doubts at all as to whether such data as that given in the article is "sound and reasonable?" We should have expected that the editorial doubts would have been excited by the very modest figures of the output. Hundreds of tons weekly are very lightly handled. There are no doubts that so large a share of the world's supply of copper will go through the Elmore Companies' hands. From such huge sales we fear the "clever French coppersmiths" are unlikely to hammer many "beautiful forms." They are probably clever enough to buy in the cheapest market, and as "copper ranges higher in France than in England," they will have to pay more than the 2s. per pound for Elmore, over the cost of ordinary copper, which the English company is going to be content with.

The *Financial News* recalls the fact that it published an article on the Elmore Companies last February. The "orders a year in advance" did duty then. In commenting (February 20th) upon that article we wrote as follows:—"The information at our disposal hitherto has been that the output for 1891 was contracted for by an important group of wire drawers. Is the 'year in advance' the same as the output for 1891,' and the 'Birmingham syndicate' the same as the 'important group?'" No answers to those questions have been given. It is now June, 1891, and still the "year in advance" does duty, but in a slightly different way. It does not read as if the orders still held good, but the fact that considerable orders were given a year in advance is claimed to be of some significance. Undoubtedly it is, and we hope in due time the significance will be demonstrated.

We can quite understand that those interested in the Companies would like confidence to be restored, but it cannot be done by such articles as that of the *Financial News*, though it retails the confidence of Mr. Elmore, the faith of the directors, and the nonsense of M. Secrétan. The Companies have been formed and the works running a considerable time. Why, then, are we treated to exactly the same estimates of cost as we had in the original prospectus, with "repeat orders," "rapidly developing business," and similar phrases? The company should be in a position to know exactly the cost of production, works expenses and also establishment charges. If a technical journal states that the product is of a foliated character and exfoliates when subjected to heat, why does the company, or those who speak in its name, be-little their business by saying that the best answer they can give is "repeat orders." It is no answer at all. The charge refers to steam pipes, the repeat orders may be for hydraulic rams, and super-heated steam is not a contingency to which hydraulic rams are subject. The charge relates to heat tests. The answer gives figures for mechanical or cold tests such as were made before us at the press visit. Confidence is a plant of slow growth and quick decline. If it is desired to arrest that decline, it should be plainly stated what is the extent of the business done, the cost of doing it, and the profits resulting.

The *Financial News* commences its article with these words :—"The recent slight improvement in the market value of the shares is due, we suppose, to the progress which the works are making, and to the commercial prospects held out by the advocates of the Elmore process." The progress of the works involves the expenditure of the shareholders' money, and we are not aware that the advocates of the process have lately claimed any increase in the commercial prospects over those previously held out. It seems to us that the simultaneous appearance of the *Financial News* article and circulation of the extraordinary letter of Mr. Peck, of which we give extracts in our correspondence columns, points to proceedings far more likely to affect quotations than the causes ascribed by the *Financial News*.

From the time when we saw that the Elmore business was likely to be serious for investors we set ourselves the task of placing before the public the true meaning of the misleading statements put into circulation. Though it become somewhat irksome we shall continue to carry out that task. Our regret is that it is impossible for a technical journal directly to counteract the harm which may be done. If the article now referred to is a fair sample of the information upon which the general public invests in industrial undertakings the general public has our cordial sympathy.

ELECTRO-CULTURE.

UNDER the heading *L'électro-culture*, Mons. G. de Dubor discusses in a French contemporary at some length the effects of electricity upon plant life.

The application of electricity in the cultivation of plants is by no means a new idea. Some experiments appear to have been made by Mambray in this direction as early as 1746, but although the notion has been simmering in the minds of certain scientists almost ever since, but little progress has been made.

Some have investigated the effects of the rays of electric light upon vegetation, whilst others have studied the action of electric currents upon the growth of plants. There are thus two ways of approaching the subject, and those who have given any attention to it have chiefly concerned themselves with the action of the electric light.

Mons. de Dubor gives some account of the history of the experiments which have been made. In 1806, we learn that de Candolle gave a great deal of time to the examination of the behaviour of plants under the action of electricity, but with little result, for the science of electricity was then but little advanced. Later, Hervé-Mangon and Prillieux worked upon this curious subject of research.

The most interesting experiments, however, that are recorded are those due to Grandeau, Naudin, and Siemens. Grandeau endeavoured to prove that electricity was a vital necessity to vegetation. One of his experiments was the following :—Several tobacco and maize plants were placed in an insulated position and surrounded with a continuous metallic cage ; after being carefully tended under these conditions for several months, it was observed that the plants had become unhealthy, whilst similar plants not thus surrounded grew normally. A critical observer, however, would not be inclined to attach very much importance to this experiment.

Naudin performed a less negative experiment. He planted tomatoes, lettuce, beans, &c., and surrounded them with an iron wire cage in such a way that electricity could be freely supplied. The results obtained by this treatment were somewhat significant. The beans grew to a larger size and looked more healthy than those which had not been thus treated. The lettuce under the cage attained an average height of 1·20 m., and weight of 427 grammes, as against a height of 1·0 m. and a weight of 337 grammes when grown in free air. The tomatoes grew to an average height of 1 metre and weight of 3·754 kilos, whereas in free air the height was 80 cm. and the weight 3·627 kilos.

In England Siemens has made much more searching experiments, especially regarding the influence of electric light upon vegetation. One of the investigations lasted seven months, and the plants were grown in two small greenhouses. Two lamps were employed, emitting a light equal to that of 5,000 candles ; one of these was placed in one of the greenhouses, and the second was suspended at a height of 4 metres above the other. The temperature was maintained as uniform as possible at about 15° Centigrade.

Several kinds of seeds were sown and plants set in. The results were distinctly unfavourable, especially in the greenhouse which was lighted by the lamp placed in the interior. In a few days the leaves and the young shoots rapidly faded and became as it were scorched.

Siemens then thought of softening the intensity of the electric light by covering it with variously coloured glasses. By this means he was enabled to demonstrate that vegetation proceeded rapidly when white glass was used ; that it was much slower under yellow glass, and that in this case the plants were less vigorous and paler in colour ; that red glass produced a mediocre growth, whilst the foliage was meagre and yellowish : finally, that blue glass yielded the worst results of all.

When white glass was used, raspberries planted on December 16th bore fruit on the 1st of March. Strawberries planted on December 10th furnished ripe fruit on February 14th. Vines planted on December 26th gave excellent grapes fully ripe on March 10th. With cereals there was equally rapid growth ; peas germinated in two days.

It appears, then, that the effect of the electric light upon plants is of a very powerful order, and such experiments open up an exceedingly interesting line of research which might lead to really practical results.

The first attempts to apply the electric light to cultivation upon the large scale were made in England by Sheppard ; others also endeavoured to make use of it, but with indifferent success. More recently a distinguished Russian agriculturist, Spechnew, has been carrying on a series of experiments on the large scale for six years without interruption.

Spechnew commenced by applying electricity to the germination of wheat, and he observed that the growth was much more rapid when this application was made than under ordinary circumstances.

He then employed dynamic electricity, burying large plates of zinc and copper, connected with wires, in the soil in which were grown beans, carrots, &c., and in every case he obtained a finer crop.

Static electricity was next experimented with, the plants were arranged within the influence of collectors of atmospheric electricity. For five years experiments were systematically carried on, and the results appear sufficiently indicative of the powerful action exerted by electricity in the growth of plants. Here are some figures for comparison; in each case the same quantity of seed being sown.

		Electric Culture.	Ordinary Culture.	
Rye ...	Grain—	1,640 kilos ...	1,282 kilos	per hectare.
	Straw—	4,480 „ ...	2,800 „	
Corn ...	Grain—	2,000 „ ...	1,290 „	„
	Straw—	2,500 „ ...	2,690 „	
Potatoes	Tubers—	19,500 „ ...	17,500 „	„
	Hulm—	2,400 „ ...	1,800 „	

Similarly good results have likewise been obtained by Barat, an agriculturist of Aiguillon, who experimented with potatoes, tomatoes, and other vegetables exposed to the action of a current of electricity. In the case of the potatoes, the yield was nearly doubled, and an increased crop was invariably obtained with other vegetables. Barat, who commenced his experiments in 1880, proposes this year to carry them on on a still larger scale, and under the control of competent persons.

Now, the first question to ask in connection with these interesting experiments is—How does the electricity act on plant life? This is a crucial question, but Spechnew, who has made numerous chemical analyses, is inclined to formulate the theory that the currents hasten the dissolution of the organic principles in the soil, which thus become more readily assimilable by the plant.

But although these experiments look well, it by no means follows that all scientists will accept them, or indeed attach much importance to them; the results which are claimed to have been obtained should be received with reserve. Further experiments are necessary—experiments which shall be scientifically conducted and properly controlled; then, when a large number of observations have been accumulated, it may be possible to deduce some important generalisations one way or the other.

BALATA GUM.

UNDER the title of "Balata and the Balata Industry," Mr. G. S. Jenman, Government Botanist in British Guiana, has recently compiled an exhaustive report on Balata, or chicle, gum. A few extracts from this report may prove of interest to our readers.

The "bullet-tree," from the bark of which the gum is obtained, is of considerable size, growing to a height of 120 feet; its habitat ranges from Jamaica to Trinidad, Venezuela and Guiana. Mr. Jenman classifies it as a "Mimusops Balata," there being, apparently, two species, the one found in Jamaica and Trinidad, referred to as "mimusops globosa," differing from the Guiana type.

The bark of the tree is about half an inch thick, with deep parallel fissures about an inch apart; the wood is reddish in colour, very hard, and employed wherever strength and durability are required.

The trees appear to affect the depths of the forest region some distance from the main rivers, they being most plentiful between the Berbice River and the Corentyn; they are, however, found in great numbers extending eastward of the Corentyn into Dutch Guiana, and in this district a grant of several hundred thousand acres has been obtained by an American firm engaged in the collecting of Balata.

With regard to the character of the gum, Mr. Jenman says its strength is very great, and since it does not stretch under tension, it is particularly well adapted for special appliances, such as machinery bands.

In the report on the Balata, Dr. Hugo Müller, F.R.S., says that it "commands a higher price than gutta-percha, and that it can be used in almost all cases where gutta-percha is employed." He states that although Balata is treated by manufacturers simply as a superior kind of gutta-percha, it is really distinctly different, especially in some of its physical characteristics; for instance, it is rather softer than gutta-percha at ordinary temperatures, and not so rigid in the cold. In the effects produced by exposure to light and air, a very marked difference is observable between Balata and gutta-percha. The latter becomes altered on the surface, and changed to a brittle resinous substance, into which the whole of the mass is converted in course of time; Balata, on the other hand, is but slowly acted upon under these circumstances. The electrical insulating properties of Balata are said to be quite equal to those of gutta-percha.

The milk is collected by cutting two parallel incisions in the bark to a height of about eight feet; the lower extremities of these incisions are brought together near the base of the trunk, and at the apex of the angle thus made the bark is slightly lifted, and the rim of a calabash, into which the milk trickles, is inserted. The milk runs for from 40 to 60 minutes, and from a tree of 15 to 20 inches in diameter, about three pints of milk can be obtained if the yield be favourable.

The best collectors do not injure the trees, and always tap them on the opposite sides, leaving the intervening spaces for subsequent years. In careless collecting—the too general rule, we are told—every stroke of the cutlass penetrates the bark, ultimately causing the death of the tree, and it is too frequently the custom to fell the trees, tapping them by cutting parallel transverse lines at intervals of about a foot.

The milk is dried by pouring it into shallow wooden trays, previously rubbed with oil, soap, or grease, in order to prevent the gum sticking to the sides; it is then exposed to the air, and sometimes to the sun, in fine weather requiring two or three days to dry, and in wet weather a week or more. When sufficiently dry to be removed from the trays, the sheet is thrown over a line or bar to drip and harden.

A good deal of foreign matter is found in the milk, and Mr. Jenman states that adulteration is so systematically carried on that the agents, who buy the Balata in the milky state and have it dried themselves, must be constantly on their guard against the introduction of inferior admixtures.

It would appear that some action on the part of the Government is necessary to control and regulate the collecting of Balata, otherwise the time cannot be far distant when this tree will have disappeared as completely as has the Isonandra gutta from the Malay Archipelago.

THE CITY AND SOUTH LONDON RAILWAY.

IN these days of severe competition the "magic penny" forms an important factor in the progress and success of those commercial undertakings engaged in the transport of human freight. The introduction of penny fares by the omnibus, tramway, railway, and steamboat companies has greatly developed their traffic ; it has permitted passengers to travel from, say, over one mile in the case of the two first-mentioned, to about three miles in the case of the river steamboat service ; it has immensely augmented the number of people carried, and consequently the receipts of the various companies ; and it has almost invariably enabled the latter to earn more remunerative dividends than would have obtained had a higher charge been enforced. Penny fares, in fact, greatly encourage traffic, and especially is this the case in the metropolis with the tremendous number of people travelling to and fro daily ; a higher rate would act as a deterrent.

It was, perhaps, after a consideration of these facts that the City and South London Railway Company recently decided to introduce penny fares. Two other causes have also very probably helped to bring about this result. One was the complaints of workmen, who grumbled at having to pay 2d. for travelling a short distance, and the other, the diminished receipts from April 4th to May 9th, as given below :—

Week ending.	Receipts.
April 4th	£901
„ 11th	827
„ 18th	816
„ 25th	784
May 2nd	733
„ 9th	695

The sum of £901 is the highest weekly receipt since the opening of the line on the 18th December last, but this amount included the additional traffic incidental to the Easter Bank Holiday.

Returning to the question of reduced fares, we find that on the 11th ult. the company commenced to run trains at penny fares for workmen between the hours of 6.45 a.m. and 8 a.m. from the Oval and all stations on to King William Street. This was followed, on the 21st ult., by the introduction of penny fares after 10 a.m. up to 11 p.m. from the Elephant and Castle—the exact half-way station of the line—to the City or to Stockwell. On Monday, a correspondent informs us, the penny fare was adopted at the Borough Station for trains in either direction.

The first reduction may probably have caused an increase in the number of passengers carried, but it did not effect an augmentation in the receipts during the first week, the figures being £665 as against £695 in the previous week. This was probably due to the fact that it was not generally known that the fare had been lowered. When, however, the second concession was made, the receipts increased from £665 during the week ending May 16th to £768 on May 23rd, this being doubtless due to the greater amount of traffic consequent upon the reduced fare. The amount taken last week was also £768. Of course the condition of the weather may possibly have an effect upon the traffic, but even this may only be very slight.

It is not proposed to adopt generally penny fares for short distances, as such a policy would necessitate the issuing of tickets and consequently a great increase in the working expenses. There is little doubt that the introduction of penny fares will result in the carrying of a larger amount of traffic which should be beneficial to the company, and the directors must be congratulated for having inaugurated cheap transport facilities on that railway. They are also endeavouring to improve the lighting of the carriages. Let it be soon !

The Federated Institution of Mining Engineers.

A GENERAL meeting of this young but progressive society was held in London last week under the presidency of Mr T. W. Embleton. In the course of his inaugural address which referred to the progress in various industries since 1830, the president stated that :—"As to electricity, it was then (1830) a toy ; the revolving of a glass cylinder, on which was a piece of silk, produced what was required. When all was in readiness you were placed on a stool with glass legs ; you held in your hand a wire in connection with the machine, you were covered by the electric fluid, and the company amused themselves at your expense by touching you to take a spark from you, and you to feel the sensation of being pricked. Or Leyden jars were filled with electricity and discharged —to the great amusement of the bystanders. What was then a plaything has now become a valuable agent. Continents hold converse with each other, thus, as it were, bringing the countries nearer together, and at the last we are able to talk with each other by means of the telephone ; and recently by the under-sea telephone a person sitting in England can hear the music of an opera being performed in Paris. Words and messages can be registered and used on any occasion when required—indeed, the electric fluid can be stored and carried from place to place. Already has electricity been employed in lighting towns and buildings. It is in use in Yorkshire for underground haulage, pumping, and coal-cutting with success. On short railways it is the motive power. Indeed, in many processes it is essentially necessary." —A number of miners' electric lamps was on the table for the inspection of the members, but none of the makers who had forwarded the lamps took the trouble to have a representative present to explain the details of the apparatus to the mining engineers, the result being that but little interest was manifested in the exhibition. Most of the lamps were not even labelled with the names of the manufacturers, but among those shown were the lamps of Messrs. Cathcart and Peto, Mr. James Pitkin, and Mr. L. Bristöl. Various works were open for the inspection of the members—the City and South London Railway, the Deptford Station, the works of the General Electric Power and Traction Company, the Barking Electric Tramway, and the Electric Launch Station at Platts Eyott, Hampton.

Patent Medicines.

WE would recommend the perusal of an article written by Lee J. Vance in the current issue of *Popular Science Monthly*, entitled "The Evolution of Patent Medicine." Here will be found some instructive reading : the evolution of quackery from magical practices and secret charms is traced, and the blind, unthinking faith of the dupes is compared with the belief which savages have in magical remedies. The vendors of electric or other charms will, moreover, receive some good home-thrusts if they read the article through ; but, of course, they will only be amused, for are not their skins pachydermatous ? and do not the golden coins still roll in ? Besides, as the late P. T. Barnum once bluntly remarked, people like to be humbugged, therefore anyone who will indulge them in this luxury is surely a public benefactor. Here is a paragraph which we cannot help quoting :—"Frankly speaking, nostrum vendors no longer rely on the curative power of their drugs. They depend now on the power of advertising almost exclusively. They have a literary man to 'write up' the remedy in ingenious fashion ; an artist to show the patient 'before and after' using the panacea ; a poet to compose odes and lyrics ; a liar who rivals Munchausen ; and a forger who signs all sorts of testimonials. The great point seems to be to make people feel that they are in the last stage of decline. A cleverly-worded circular is enough to give one a fit of the blues. In the opening chapter of his amusing book, 'Three

Men in a Boat,' Mr. Jerome hits off this particular point: 'I never read a patent medicine advertisement' says one character, 'without being impelled to the conclusion that I am suffering from the particular disease therein dealt with, in its most virulent form.' It is not uncommon for the nostrum vendor to offer 1,000 dollars reward for any case he fails to cure. He is safe enough, even if the remedy kills, for there is no time specified within which a cure is to be effected. To this, then, patent medicine comes at last, 'This wonderful remedy works like a charm,' or else not at all."

The Pouyer-Quertier Cable Company.

OUR readers will remember that not many weeks ago the judgment of the Council of the Prefecture, favourable to the Compagnie Française du Télégraphe de Paris à New York, in the action between it and the Anglo-American Company, was reversed by the Council of State which upheld the legality of the agreement between the two companies in respect of a joint purse. The French company was in consequence compelled to come before the Government in order to obtain from it full and express instructions as to the division of its receipts with the English companies. As a result of these proceedings, the Minister of Commerce, under date of the 21st May, has notified the French company that if it should return to the régime of a common purse, in accordance with the agreements entered into with the English companies in 1880 and 1882, the Government would condemn the said agreements since they constituted a fusion of interests prohibited by Article 9 of the French cable concession, and that according to the terms of Article 13 of the said concession, the agreements with regard to the common purse would be annulled. The matter will in consequence come again before the Court of Appeal. The decision of the minister, inasmuch as it is favourable to the French company, has caused an important rise in the value of the shares.

Andrews's System and the Fire Offices.

THE Andrews' system of wiring interiors was again under discussion by the Fire Offices Committee at their last meeting, and a report on the system by Dr. John Hopkinson was read, setting forth many advantages for the system, and pointing out that there is no danger whatever to be apprehended, because the system has a bare outside conductor involving an earth connection. A statement by Mr. Andrews was also read, and several testimonials from users of the system. The result of this overwhelming evidence induced the committee to reconsider their decision of the former meeting, and they passed a resolution by which the system is freed from its fetters, and it now stands on an equal footing with the wood casing competitor.

Random Shots.

WE have had brought before our notice a leading article in our contemporary, the *Electrical Engineer*, on the lighting of Cambridge. The subject of the article is a report of the sub-committee of the Cambridge Town Council appointed to report upon the various schemes and tenders submitted to the Town Council for the laying down of an installation to commence the lighting of the town of Cambridge. There appears to us nothing in the report calling for special reference, excepting that among other provincial electric light stations that of the Newcastle and District Electric Lighting Company was visited, and that there steam turbine alternators are used. The Committee, it appears, formed a very favourable impression as to the economy in first cost and cost of maintenance and supervision, incident to this class of engine and dynamo. This appears to us to have aroused our contemporary's bitter —and, as they appear to us, misplaced—criticisms, and, as we happen to have before us further and more reliable information than our contemporary can possses, we may at once say that its statements are quite incorrect. In drawing the comparison of coal used at Newcastle as 23·4 lbs. per unit sold, with Mr. Crompton's 11 or 12 lbs., our contemporary ignores the fact that Mr. Crompton's stations are on the low tension storage battery system, which enables the plant to be worked more economically as regards coal, but involves a much heavier first cost and an additional cost of maintenance of accumulators, while the Newcastle plant is on the high tension transformer system, which has hitherto always been considered more wasteful in coal. It also ignores the fact that the coal used at Newcastle is of an inferior quality, having at least 18 per cent. less evaporative efficiency than that commonly used in the South of England. Besides all this, we happen to know that the saving in coal that Mr. Parsons is obtaining from his condensing steam-turbines is not far from 50 per cent. over the non-condensing turbo-generators as hitherto used at Newcastle, or exactly one half the fuel is used. We also hear that these results are being verified by some independent men of science.

Electric Light Companies and Litigation.

As electric lighting companies become more fit to take their position in the commercial world, there will be a corresponding increase of legal actions against them. Whether this be a sign of vitality or not is a matter of opinion. There is little doubt, at any rate, that electric companies now appear frequently in the law courts, and in most cases as defendants. There are, unfortunately, in this world many persons who do not hesitate to embark in legal actions if there is a possibility of them resulting in profit, and this spirit may have been responsible for many of the applications for injunctions against electric light companies. The case, however, to which we would draw attention this week is an action brought by Messrs. Hampton & Co., the well-known Pall Mall upholsterers, against the London Electric Supply Corporation, to recover damages laid at £5,000 for alleged breach of contact to put in an installation. The Corporation denied the contract, but at the same time paid into court £75 to satisfy any claim. Without going into the details, which may be found in another column, we may say that the jury returned a verdict in favour of Messrs. Hampton and Co. for £250, but the judge, Lord Coleridge, disregarded this verdict, holding that there was no evidence of contract, and entered judgment in favour of defendants. While admitting the reasonableness of his Lordship's view, we think companies ought to look after their interests in such a way as to preclude the possibility of legal actions. If carefully worded contracts were made, in which it were clearly stated that the companies would not be responsible in case of breakdowns, much trouble would be saved. It would appear that Messrs. Hampton recognise the superiority of the electric light over any other illuminant, for in their plaint they say that it was necessary to adopt less effectual means of lighting, and this was almost, if not entirely, the cause of a decrease in business of £20,000.

A Large Output.

IN the *Steamship* for this month we notice a description of Joel's slow speed dynamo, in which we observe a statement to the effect that one of these machines gave current for 230 16-C.P. lamps, with a 9 H.P. nominal Crossley gas engine driving it. Perhaps some of our readers knowing the relationship between nominal and brake horse-power will tell us whether this is likely to be a fact, or whether it is not more feasible to suppose that the lamps were only half incandesced. If we take a 16 C.P. lamp as consuming 60 watts, we arrive at the result of 12½ lamps per electrical horse-power; the 9 H.P. Crossley gas engine must then have developed over 20 brake horse-power to allow for 18½ electrical horse-power at the lamp terminals. Can it be possible?

DEDUCTIONS AND EXPERIMENTS ON ROTARY CURRENTS.

By A. DU BOIS-REYMOND.

THE diagrams, fig. 1, are copied out of a well known treatise on physics.* They are meant to show how elliptical and circular polarisation of light is obtained. An atom of ether simultaneously performs two simple sinusoidal oscillations of equal period, the directions of which are perpendicular to each other. For each phase the radius vector of the resulting movement is the diagonal of a parallelogram, the components of which are the two distances from the centre which the atom would have reached at that phase if it performed only the one or the other of the two simple oscillations. Thus the curves of the first group in fig. 1 are obtained, if between the two simple oscillations a phase difference of $\frac{0}{8}$, $\frac{1}{8}$, $\frac{2}{8}$, $\frac{3}{8}$ . . . . $\frac{8}{8}$ of the period occurs and their amplitudes are equal. The curves of the second group, fig. 1, are obtained in the same way, if the phase difference between the two component oscillations is always 90° or one quarter of the period, while their amplitudes successively take different values.

FIG. 1.

Even if the identity of optical and electromagnetic phenomena had not yet been made an article of our scientific faith by the work of Clerk Maxwell and Mr. Hertz, the merely external similitude of the elliptical and circular polarisation and the phenomena of electromagnetic rotation produced by rotary currents would strike us. And likely enough this analogy may have influenced the inventor of electromagnetic rotation, Mr. Ferraris, in the execution of his fundamental experiments.

He simply substituted the two superposed oscillations of the atom of ether by the variations of two superposed magnetic fields and obtained a resulting field, the direction and intensity of which is defined by the direction and length of the radius vector of the corresponding curve of optical oscillation.

When such a rotary field is to be employed to drive electromotors, its intensity and angular velocity ought to be as nearly as possible constant, or, to use the optical expression, perfectly circular polarisation ought to be aimed at. Therefore the conditions which underlie the attainment of this object deserve our particular attention. In fig. 1 we find that the oscillation curve becomes a true circle only in those cases in which the amplitudes of the two component oscillations are equal, and in which the phase difference is 90°. But here the analogy fails, because the optical oscillations only interfere in such a way that the directions of the two components enclose an angle of 90°. Mr. Ferraris, also, has not gone beyond this point, most likely because the optical polarisation theory was before his mind's eye. He begins his famous treatise on electro-dynamic rotations* with these words :—

"Sia O un punto di uno spazio nel quale si sovra pongono i campi magnetici prodotti da due correnti elettriche ; le direzione O X ed O Y che hanno i due campi magnetici nel punto O sieno diverse, per esempio perpendicolari l'una all' altra," and he sticks to his assumption through the rest of his paper ; whereas, if we do away with this supposition, we find that perfectly circular oscillation curves always result, supposing only that the amplitudes of the two components are equal, and that the angle which their directions contain is the supplement of the angle of phase difference.

If more than two component oscillations are combined, this rule is subject to a number of modifications, which, however, we need not follow up.

In the first case of the first group, fig. 1, the phase difference was nought. If we turn the second component, till it encloses an angle of 180° with the first, the resulting oscillation curve shrinks away and becomes a point, fig. 2, first case. If we make the components in the second case to contain an angle of 135°, we will obtain a circle, fig. 2, second case. In short, the first group of curves in fig. 1 becomes the group fig. 2, if we make the angle contained by the components equal to the supplement of the phase difference. However, the diameters of the circles so obtained, or in electro-dynamic rotation the intensities of the rotary fields, are not equal to the amplitudes as in the circles in fig. 1, but only equal to the product of the amplitude into the sine of the angle contained by the components.

FIG 2.

From the point of view thus gained, we can easily form a judgment on the nature of the resulting rotary fields obtained in a few practical cases that have been described in the literature of the last few years. In the first place we would consider the two experiments described by Mr. Ferraris himself.

He says that the two alternating currents necessary for exciting the component fields may be obtained from one single alternating current. He excites the coil, which makes the one component field, and the primary, the coil which makes the other component field, with the secondary current of a transformer. By giving each coil the right number of windings, it is easy to make the ampère-windings in each, and thereby the amplitudes of the component fields equal.

However, the phase difference between the primary and secondary current of a transformer is always a larger angle than 90°. Suppose, for instance, that this difference amounts to 135° (a case which is altogether within the limits of practicability), then the radius vector which defines the resulting field obtained would not describe a circle, but would describe one of the ellipses shown in the fourth and sixth case in the first group in fig. 1. Had he hit upon the idea of disposing his exciting coils in such a way that their magnetic axes had contained an angle of 45°, he would have obtained the corresponding curve in fig. 2, viz., constant angular velocity and constant intensity.

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* Lehrbuch der Physik und Meteorologie von Dr. Joh. Müller. 8te. Aufl., Bd. II. Abth. I., S. 611.

* Galileo Ferraris. Rotationi elettrodinamiche prodotte per mezzo di correnti alternate. Torino, 1888.

Exactly the same may be said of his second method. He splits an alternating current into two branches, into one of which he inserts a small resistance and great inductance, into the other a large resistance and small inductance. The phase difference in this case may approach 90°, but will always be smaller. Let us assume it to be 45°, for instance, then the resulting curve will again be one of the two ellipses, case second and eighth in the first group of fig. 1, supposing, of course, that the ampère windings in both coils have been made equal. Again, he might have obtained perfectly circular polarisation of his resulting field if he had disposed his coils so as to contain an angle of 135°.

The first of Mr. Ferraris's two methods has been introduced into regular use in the Schallenberger meter. This well-known instrument substantially consists of a coil, through which flows the alternating current that is to be registered. A second coil, short-circuited in itself, is disposed in such a way that the magnetic axes of both contain an angle of 135°. The resulting rotary field turns an armature, the revolutions of which are counted.

In the second coil a secondary current is generated, and according to the well-known rules that govern the processes in a transformer, the intensity and phase of the primary and secondary currents in this case will be approximately as $\sqrt{2}$: 1, and the phase difference between the two will be 135°. Therefore neither will the amplitudes of the two component fields be equal, nor will the phase difference correspond to the angle contained by the components. Consequently the resulting oscillation curve will be a stretched ellipse. However, since Mr. Schallenberger does not intend his apparatus to yield an appreciable output, the fluctuations of the field intensity will not do much harm. They may even be of some use by counteracting the mechanical inertia of the armature.

Still more imperfectly than in the Schallenberger meter the conditions for constancy of the velocity and intensity of the rotary field are fulfilled in one of the newer motors of Mr. Tesla, in which the inventor makes use of the second Ferraris method.

In the description of this motor, which *Electrical World*, Vol. xiv., p. 382, gives, a four-pole design is chosen, so that the angles contained by the composing fields ought to be expressed as parts of half a circumference, or by half degrees, in order to suit our rule. Eight radial electromagnets are disposed at equal distances on the inside of an iron ring, and are wound in such a way that every second bobbin has a low resistance and high inductance, and they rest *vice versâ*. Each set of bobbins is connected in a series, and both sets in parallel.

Since the phase difference between the two currents connected in parallel can never reach 90°, and in this case we cannot even freely choose the values of inductance and resistance, most likely a difference of 45° will hardly be attained.

In that case the resulting field would be illustrated by case second, fig. 1, that is by a somewhat stretched ellipse.

A similar result is obtained in all motors in which only one current is used to obtain a rotary field, no matter whether the first or the second Ferraris's method is employed or a combination of both, as in another of Mr. Tesla's motors.

The question now arises to what extent the constancy of velocity and intensity is really attained in such motors, in which, according to the rule of the parallelogram, the necessary conditions are fulfilled. As far as I am aware, Mr. von Dolivo-Dobrowolsky has been the first to ventilate this question.* He assumes that the actual intensity of the resulting field in every moment is proportional to the sum of all ampère windings, and calculates the value of the fluctuations of intensity by simply adding up the ampère windings. However, this way of attacking the question can only lead to a very rough approximation, for if it were strictly correct no rotary field whatever could be produced, since its production is built up on the law of the parallelogram.

But, before we enter into the discussion of this question, I would like to insert a few words about the classification of the practical forms of rotary current motors. The first technical realisation of the Ferraris principle, the Tesla motor, is substantially defined by the sketch, fig. 3. Each of the two iron rings, I and II, is wound with four coils, which are connected together in the well-known way, making two perfectly independent equal circuits.

FIG. 3.

In fig. 4 one of these two separate circuits is taken out and stretched out straight in order to show by the dotted line how the potential varies in its different parts. In the two coils, I, of the generator, the potential rises up steeply, falls off gradually in the conductor, f_1, then again falls off steeply in the two coils of the motor, and finally comes down gradually in the return wire, f_2, to its original value. When the circuit is perfectly insulated from earth the potentials in the two short connecting wires, v_1 and v_2, will be equal to the potential of the earth, but in all cases they will be equal. Therefore, if we connect the points, v_1 and v_2, no current will pass through the connection, nor will the whole system be in any way electrically disturbed. Moreover, since both circuits in the system are perfectly equal, it follows that we may also short circuit the two points, v_1, of the two systems in the generator, and the two points, v_2, of both systems in the motor, without introducing any electrical alteration whatever, and we obtain thereby the new system, fig. 5. This deduction shows that between the older motor of Mr. Tesla and the newer forms recently designated as rotary current motors there is no real difference.

FIG. 4.

FIG. 5.

Recently it has been shown that the number of coils on one ring may be reduced to three, connections being made in the same way as in the Thomson-Houston armature. By dividing each one of these three coils into two halves and winding each half diametrically opposite the other, also according to the example of the Thomson-Houston armature, we finally arrive at a system which allows of driving a six-coil motor with three conductors carrying three simple alternating currents. Thus we obtain the three patterns of three-coil, four-coil, and six-coil rotary current motors, fig. 6, which no doubt will technically be the most important.

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* Kraftübertragung mittels Wechselströmen von verschedener Phase (Drestrom) von M. von Dolivo-Dobrowolsky. Elektrotechn-Zeitschr, 1891, p. 149 and 161.

FIG. 6.

These three types were therefore subjected to a series of experiments by Messrs. Siemens and Halske, the results of which are laid down in the following :—

An iron ring supplied with a continuous winding was taken from an experimental model, and the winding was divided into three, four and six equal parts respectively. Each part was excited by a perfectly constant continuous current, and the intensities of these exciting currents were so adjusted as to correspond to any phase of the three, four, or six alternating currents, in which the resulting field was to be studied. In this way, for each phase of rotation, the resulting rotary field was made stationary, and the possibility attained of studying its shape by making diagrams of iron filings, and its intensity and direction by corresponding measurements. Thus the diagrams, fig. 7, were obtained, which show the actual variation of the rotary field in the three, four and six-coil motor, when, according to the law of the parallelogram, the resulting field ought to appear advanced from 30° to 30°. The two concentric circles define the edges of the ring, the radial marks show the ends of the single coils. The arrow gives the direction of the resulting field as constructed according to the law of the parallelogram of forces.

The most interesting results are those shown in fig. 7*a* giving the rotary field of a three-coil motor. The resulting magnetic axis is mostly curved, except in those cases in which the excitation is quite symmetrical; and even then the lines of force appear contracted at one pole and spread out at the other (fig. 7*a*, I. First coil 0·0 ampères, second coil : + 8·7 ampères, third coil : — 8·7 ampères). But as soon as the excitation becomes asymmetrical, we obtain a curved magnetic axis, and besides greatly different intensities of the two poles (fig. 7*a*, first coil : + 5·0 ampères, second coil : + 5·0 ampères, third coil : — 10·0 ampères), and so on.

The four-coil motor fig. 7*b*, gives a considerably better result. The magnetic axis is always straight, and both poles have equal intensities. The six-coil motor shows a still more equal resulting field, fig. 7*c*.

In order to measure the intensities of the rotary field, a coil was hung in the centre of the ring, in such a way that its magnetic axis was perpendicular to the measured direction of the resulting magnetic axis of the ring. The coil was then excited by a constant continuous current, and was kept in its position by a spring. The torque of the spring served as a measure of the intensity. The horizontal component of the magnetism of the earth could be neglected in these measurements, because the ring surrounding the measuring coil effectually served as a magnetic screen.

The following table gives the results obtained, but the diagrams, figs. 8, 9, 10, contain them in a more convenient form. In the diagrams, figs. 9 and 10, the results obtained are shown in the following way. For each measurement which shows a progress of a thirty-sixth part of one period against the last, and which, therefore, according to the law of the parallelograms, ought to show a progress of the resulting axis of 10°, a radius is drawn, the direction of which defines the actually measured direction of the resulting axis, while its length is proportional to the actually measured intensity of the resulting axis. In the three and six-coil motor these measurements executed over one-third of the whole circum-

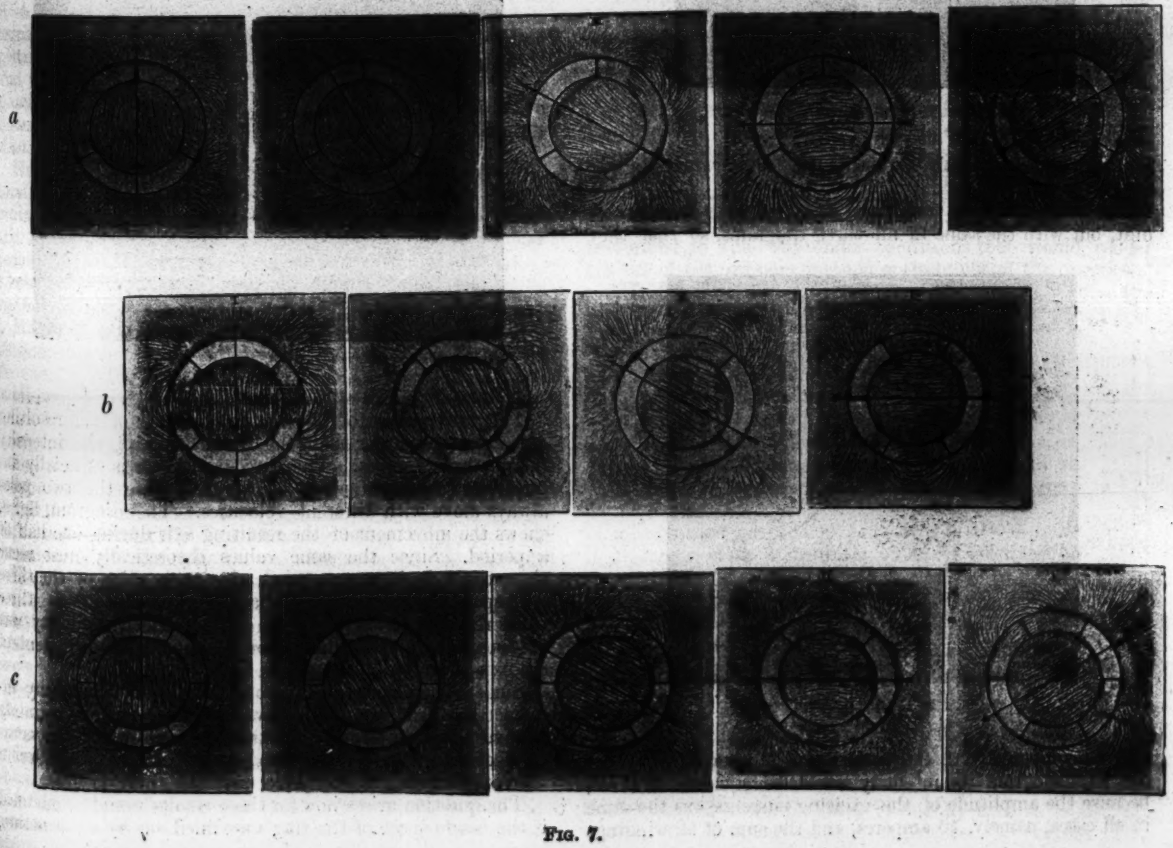


FIG. 7.

Three-coil motor.				Six-coil motor.						Four-coil motor.				
						Current in ampères in coil.			Direction in degrees of the resulting axis constructed according to the law of the parallelogram.	Current in ampères in coil.				
Measured direction of the north pole in degrees.	Measured direction of the south pole in degrees.	Mean direction in which the intensities were measured.	Measured intensity of the resulting axis.	Measured direction of the resulting axis in degrees.	Measured direction of the resulting axis.	I.	II.	III.		I.	II.	Measured direction of the resulting axis in degrees.	Measured intensity of the resulting axis.
−3	177	−3	120	3	133	0·0	+ 8·7	− 8·7	0	0·0	10·0	3	118
38	179	19	112	20	136	+ 1·7	+ 7·7	− 9·4	10	1·7	9·8	31	123
45	182	24	115	27	136	+ 3·4	+ 6·4	− 9·8	20	3·4	9·4	37	124
55	187	31	117	33	137	+ 5·0	+ 5·0	− 10·0	30	5·0	8·7	43	131
60	186	33	118	38	135	+ 6·4	+ 3·4	− 9·8	40	6·4	7·7	47	133
60	197	38	115	45	135	+ 7·7	+ 1·7	− 9·4	50	7·7	6·4	48	133
61	240	60	120	63	137	+ 8·7	0·0	− 8·7	60	8·7	5·0	53	132
60	282	81	115	78	137	+ 9·4	− 1·7	− 7·7	70	9·4	3·4	57	129
70	290	90	116	85	136	+ 9·8	− 3·4	− 6·4	80	9·8	1·7	63	125
70	294	92	119	92	140	+ 10·0	− 5·0	− 5·0	90	10·0	0·0	93	124
70	295	92	117	97	136	+ 9·8	− 6·4	− 3·4	100	...	...	...	...
79	297	98	115	103	136	+ 9·4	− 7·7	− 1·7	110	...	...	...	...
120	300	120	120	123	138	+ 8·7	− 8·7	− 0·0	120	...	...	...	...

ference, are given; in the four-coil motor, those over one-fourth of the circumference are indicated.

The actually measured values are shown in the upper right hand part of the diagrams, figs. 9 and 10. The other parts are obtained by simply repeating the same values slightly equalised.

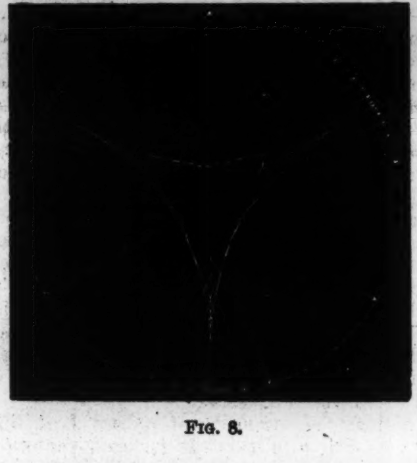


FIG. 8.

The lengths of the radii are measured with an arbitrary unit, but with the same in all three diagrams, so that they may be compared. If the resulting axis obeyed the law of the parallelogram its intensity would be equal in all three, because the amplitude of the exciting currents was the same in all cases, namely, 10 ampères, and the sum of all windings was constant. However, we find the mean intensities in the three, four, and six-coil motor as 117 : 127 : 136.

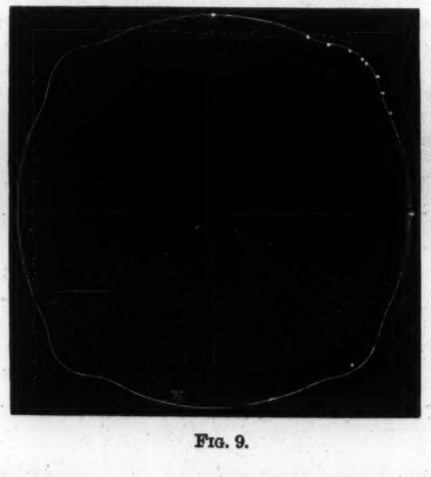


FIG. 9.

The fluctuations of intensity are not appreciable in the six-coil motor. In the four-coil motor those fluctuations reach not quite 13 per cent. of their minimum value. In the three-coil motor the measurements of the intensity are not very valuable, because the resulting axis is mostly bent. The measurements were made in this case by taking the direction of the two poles singly and hanging the measuring coil in the mean direction equidistant from both. In the diagram, fig. 8, therefore, only the mean value of the results so found is drawn.

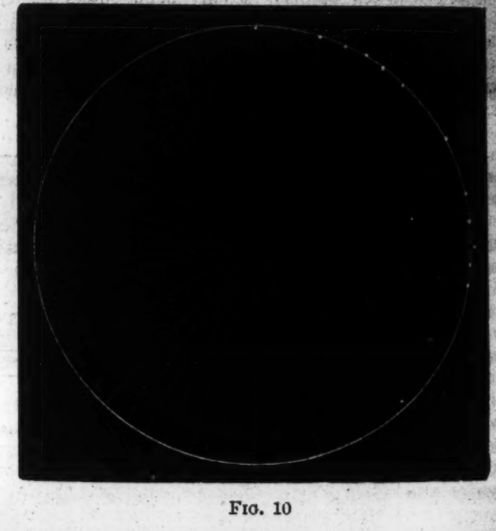


FIG. 10

The fluctuations of the angular velocity of the resulting axis are much larger than the fluctuations of the intensity in all three motors. The three-coil motor is especially interesting from this point of view, because the two poles always move with different velocities. The diagram, fig. 8, shows the movement of the resulting axis during one half of a period. Since the same values theoretically must recur three times during one period, the mean value of the three corresponding measurements actually executed was three times repeated in the diagram. Thus perfect regularity was obtained, and a good illustration of the actual movement of the axis is arrived at.

Since the velocity of the poles themselves will chiefly influence the armature, it follows that this type is certainly not very advantageous. In the four-coil motor the variations of velocity are very much smaller, and still smaller in the six-coil type.

The question arises how far these results would be modified if the inside space of the ring were filled out by an armature, and what would be the further modifications if this armature rotated. However, we can assume with a reasonable show of probability that a constant field with a constant velocity would not be changed with regard to its constancy by adding an armature, provided that the saturation of the iron were not thereby essentially altered. Whether irregularities of intensity or velocity would be magnified or compensated by a rotating armature is difficult to decide. At any rate, these experiments show that though the law of the parallelogram of forces as accepted by Mr. Ferraris ought not to be trusted unconditionally, on the other hand the assumption that the resulting field varies as the sum of all ampère windings is still further from the truth.

PECULIARITIES IN THE BEHAVIOUR OF A GALVANOMETER WHEN USED WITH THE THERMOPILE.

ONE of the most recent contributions from the Physical Laboratory of Cornell University, U.S.A., deals with certain peculiarities noticed by E. Merritt in the behaviour of a galvanometer when used with the thermopile.

When the needle is not too thoroughly damped it was observed that on suddenly exposing one face of the pile to some source of radiant heat, the needle is quickly deflected. In a short time, however, the motion becomes less rapid, and in the course of a few seconds the needle comes to rest, and in many cases moves backwards for a short distance. This behaviour is then repeated, and it is only after a long series of such "throws," which gradually becomes less and less marked, that the final steady deflection is reached.

This peculiar motion as observed in the case of a Thomson tripod galvanometer, has been represented graphically by a curve, of which the abscissa of any point shows the time that has elapsed since the beginning of the motion, and the corresponding ordinate is proportional to the deflection of the needle from its position of rest. In the case of galvanometers having needles more nearly "dead beat," the general form of the curve is the same.

Now this phenomenon was noticed six years ago by Violle (*vide Annales de Chimie et de Physique*, vi. 3., p. 373), while using a thermopile to investigate the radiation of molten platinum and silver, but he offered no explanation. Rubens and Ritter have observed a similar phenomenon with a peculiar form of bolometer, which they used for quantitative measurements of electromagnetic waves (*vide Wiedermann's Annalen*, vol. xl., p. 63).

Numerous experiments that have been made in the laboratory of the Cornell University with a bolometer of the ordinary type, and with a number of different galvanometers and thermopiles, seem to show that this behaviour is not peculiar to any one instrument, but is always observed when a bolometer or thermopile in circuit with a galvanometer is *suddenly* exposed to radiant heat.

Merritt first had his attention called to this curious phenomenon in 1888 while engaged in an investigation of the energy of the light from incandescent lamps. In a paper published in 1889 in the *American Journal of Science* (*vide* vol. xxxvii, p. 167), entitled "Some Determinations of the Energy of the Light from Incandescent Lamps," he called attention to the fact which at that time rested only upon experimental grounds, that the first throw of the needle, under the circumstances described above, bears a constant ratio to the final deflection, this ratio being independent of the intensity of the radiation to which the pile is exposed.

The phenomenon, according to Merritt, appears to be due to the inertia of the needle of the galvanometer, and to the fact that a considerable time elapses after the pile has been exposed to a source of heat before a constant temperature is reached. On account of its inertia the needle is unable to follow immediately the rapidly increasing current that flows when the face of the pile is first exposed. In a short time, however, the continued action of the deflecting force imparts sufficient velocity to carry it, not merely to the position which corresponds to the current then flowing, but to a considerable distance beyond this point. The result is that the motion of the needle is stopped and a retrograde movement begins which continues until the pile has been heated sufficiently to cause another throw forward. This behaviour is then repeated until the temperature of the pile has become constant or until the oscillatory motion of the needle has been destroyed by damping.

Assuming that the heating of the pile takes place in accordance with Newton's law of cooling, and that the electromotive force of the pile throughout the small range of temperatures with which we have to deal is proportional to the difference of temperature between the junctions, Merritt enters into a mathematical argument and deduces the equation of motion of the needle. For this we must refer our readers to the original paper, which appeared in the May number of the *American Journal of Science*, [3], vol. xli., No. 245, p. 417. Experiments are quoted in support of the mathematical deduction.

We have already noticed that the first throw of the needle bears a constant ratio to the final deflection. And it has been found that the only effect of a change in the intensity of the source of heat is to increase or diminish all the ordinates of the curve in the same proportion, the ratio of any two ordinates remaining the same. If, therefore, the final deflection of the needle is proportional to the quantity of heat received by the pile, the first throw will be proportional to this quantity and may be used in all cases instead of the final deflection.

The importance of this conclusion that the ratio is independent of the deflection (which is justified by experiment), will readily be seen by those who have had occasion to use a thermopile for accurate measurements of radiant heat. Draughts of air and other almost unavoidable sources of temperature variation frequently make the galvanometer quite unsteady, while the extreme delicacy of the instruments that must be used in work of this kind renders them especially susceptible to magnetic disturbances. Many observations are thus made valueless by a change in the zero point of the galvanometer during the three or four minutes required for the needle to come to rest. Only a few seconds are required, however, for the first throw of the needle, and the change in zero point during this time would scarcely ever be sufficient to cause an appreciable error. The use of the *first throw* in place of the *final deflection* may, therefore, lead to greater accuracy as well as to saving of time.

It will be observed that the principle underlying this method of taking readings is not confined to the case of the thermopile, but is capable of wide application. The following are suggested as cases in which the method may be employed with especial advantage :—

I. All ordinary measurements of radiant heat when the conditions are such as to make the galvanometer unsteady, or when the saving of time is a consideration.

II. For purposes of demonstration in the lecture room, a number of experiments that are usually considered unsuitable for lecture demonstration have been quickly and accurately performed in this way under conditions that would render the use of the ordinary method entirely out of the question.

III. For measurements of heat from a variable source the first throw of the needle will in this case give the amount of radiant energy at the very instant of exposing the pile.

IV. For work with a bolometer or similar instrument under the same conditions that apply in the case of the thermopile.

V. For the measurement of a constant or variable current, when it is desirable to take readings quickly, *e.g.*, the initial value of the current from a cell which is subject to rapid polarisation, may be determined by the first throw of the needle. Other applications of the method will doubtless suggest themselves. Mr. Merritt concludes by expressing the hope that a phenomenon which at first appeared to be merely a matter of curiosity, may thus be made of practical value in the laboratory.

ELECTRICAL SAFETY APPARATUS FOR MINE CAGES.

DURING the course of a general meeting of the members of the Federated Institution of Mining Engineers, held in the rooms of the Institution of Civil Engineers on Thursday and Friday last, Mr. John Yates (London) read a paper describing an electrical safety apparatus for cages. The following is an abstract of the paper :—

The author pointed out that many safety cages had been introduced, and that although their construction was faulty, they had been the means of saving numerous lives. It was, however, found that in quick winding the apparatus was apt to come into action when not required, and that it sometimes did not act when necessary. In his opinion, the conditions which a safety apparatus should fulfil were:—1. It should never fail to act when required; 2. It ought never to come into play except when the rope breaks; 3. It should allow of being tested; 4. It must be simple in construction and require little attention; 5. It should in no way interfere with the ordinary work. These conditions formed the standard to be attained by a good safety cage, and he believed the manner in which this standard might be attained was to use the hauling rope as the means for conveying a current of electricity to four electro-magnets on the cage, each magnet sustaining a gripping cam. This was a general outline of the apparatus. The rope was to all intents and purposes the ordinary hauling rope, except that it had two insulated copper wires in the hemp core. To show that such a rope could satisfactorily transmit current, it was mentioned that a similar rope was in use with Armstrong's electric signalling apparatus, which permitted of signalling taking place between the engine house and the cage whilst the latter was in motion, and which had been applied in many of the collieries in the Durham district.

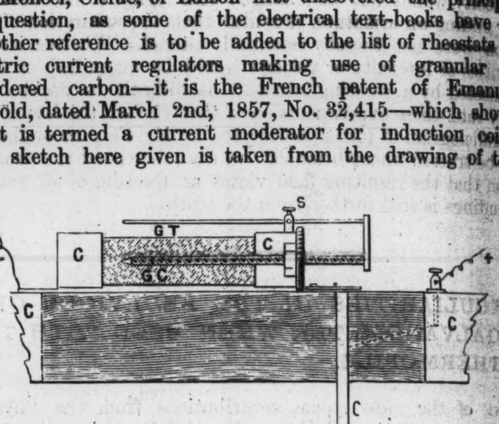
The insulated copper wires were connected at the cage end to the electro-magnets, and at the winding drum end to two insulated copper rings on the drum axle, these rings being in connection with a battery of a few cells giving a constant current. The electro-magnets were of the horseshoe type, this being considered the most suitable. The arrangement for gripping the guides consisted of four levers, each working independently of the others. One end of each lever was shaped so as to form the gripping cam, whilst the other end was heavily weighted and had a spiral spring attached. The weight and the spring tended to pull down the long arm of the lever and thereby placed the cam in contact with the guide. The electro-magnets were arranged directly over the weights, which they supported, thus keeping the cams out of action. The author considered this apparatus to be exceedingly simple as compared with ordinary safety appliances, which latter necessitated the use of a complicated arrangement of levers, bell cranks, and springs, together with, in many cases, a special suspending frame. It was claimed that, as each lever was complete in itself, the apparatus really consisted of four sets of safety appliances, the failure in the working of one of which would not affect the action of the others; that, as there were four levers, it would appear impossible for the apparatus to fail to act on the breaking of the rope; and that, as a continuous current was obtained, it was very unlikely that the apparatus would come into play when not required, for as long as the rope was intact and the current passed the levers could not come into operation. The apparatus would, the author said, act instantaneously on the fracture of the rope, and it could be tested at any time by breaking the circuit; then the weights, being no longer supported by the magnets, would pull down the long arms of the levers, and the cams would grip the guides, thus stopping the cage. Several methods of gripping the guides were provided. In conclusion, the author stated that the average miner would, after five minutes' inspection, understand the working, that it would only require two or three minutes' attention daily to keep it in proper order, that the cost of applying and maintaining the apparatus would be very small, and that it fulfilled the conditions which an efficient safety apparatus should possess.

The paper was illustrated by wall drawings, and a large model of the apparatus was exhibited.

ANOTHER EARLY GRANULAR CARBON RHEOSTAT.

By A. M. TANNER.

MY published researches concerning the variable resistance of carbon under pressure, show that in 1835, Munck, of Rosenschöld, experimented with differently compressed carbon powder for varying the force of an electrical discharge, and that in 1861 Beetz placed spongy platinum in a glass tube and compressed it more or less by means of a piston in order to change its conductivity. Hence it appears that neither Du Moncel, Clerac, or Edison first discovered the principle in question, as some of the electrical text-books have it. Another reference is to be added to the list of rheostats or electric current regulators making use of granular or powdered carbon—it is the French patent of Emanuel Reböld, dated March 2nd, 1857, No. 32,415—which shows what is termed a current moderator for induction coils. The sketch here given is taken from the drawing of the patent, and shows a glass tube having copper caps and filled with granular carbon. A screw stem penetrates into the carbon and can be adjusted by a milled nut. After adjustment the rod is held stationary by a guide stem and set screw. The strength of the current is varied by causing the screw rod to penetrate more or less into the granular carbon. It will be seen that Rebold did not propose to obtain a change of conductivity by an endwise pressure upon the carbon mass, but obviously the movement of the screw rod will produce a slight compression in the direction of the walls of the glass tube, and thus the degree of penetration of the rod and the lateral compression of the carbon granules will bring about the desired result, just as is the case in that class of microphones where solid projections on the diaphragm co-operate with granular carbon.



C, copper; G C, granulated carbon; G T, glass tube; S, set screw.

THE BLACKENING OF INCANDESCENT LAMPS.

By LEGH S. POWELL.

THE references which have lately appeared in the ELECTRICAL REVIEW relative to the depreciation in the illuminating power of incandescent lamps through blackening, and its consequent bearing on the economic length of time that lamps should be kept in use, have a peculiar interest to those who have made this department of electric lighting a special study. The tables given on page 621 of your issue for May 15th, show clearly the different degrees of darkening tendency which lamps of different manufacture possess. It is not forgotten that other causes besides blackening contribute to diminish the illuminating power, but in most lamps at least, the one under consideration is the most influential. To the manufacturer of lamps, then, this blackening feature is naturally one of the utmost importance, since in this direction lies one of the principal possibilities for further improvement. Formerly the writer was of opinion that the problem of diminishing this blackening tendency was about on a par with that of attempting to prevent water from boiling when a kettle of it is placed over a fire. But the two cases are scarcely parallel, for it is an undeniable fact that blackening occurs in very different degrees, not only in lamps of different manufacture, but even amongst their own kind. A good deal of the variation, no doubt, occurs through differences in the temperature of the respective filaments, but this cause is certainly not the only one at work. Much of the difference is attributable to the manner in which the carbon filament has been treated during its manufacture, and this fact raises the very interesting enquiry as to what cause the blackening is due, and wherefore there should be these differences in intensity?

To the writer there appear to be two possible explanations to account for the blackening phenomenon: One is the generally accepted view of the vaporisation and sublimation of the glass of carbon, pure and simple; the other, that the obscuring substance may possibly not be pure carbon but a hydro-carbon, or some allied carbon compound.

Probably every lamp manufacturer is familiar with the fact that lamps made with filaments which have been "baked" at a comparatively low temperature, blacken very readily indeed, whilst when made with others which have been raised to a very high temperature, they resist the tendency very much more effectually. Further, that the same results occur in lamps when low or high temperature flashing has been employed. He is also very familiar with the effect of different temperatures on the hardness of the resulting carbon. If then the vaporisation of pure carbon be the true explanation of the darkening of lamp bulbs, it follows that the difference in degree must arise solely from the circumstance that a comparatively loose condition of the carbon is especially favourable to the formation of carbon vapour. But the production of carbon at a low temperature would also be especially favourable to blackening, if the hydro-carbon view is the correct one. The writer can well remember when attending Dr. Frankland's lectures on chemistry, being impressed by that gentleman's assertion that to produce pure carbon by any of the usual methods is almost an impossibility, and that to free it from the ever present combined hydrogen, it is necessary to heat it in chlorine gas for days. That all hydro-carbon compounds are eliminated from the filaments in ordinary use is, therefore, extremely doubtful. In further support of the view that the presence of hydrogen may exert an influence in the feature of blackening, the fact may be cited that filaments of carbon baked at a low temperature become materially harder in process of running lamps made with them, and yet the rate of blackening, instead of diminishing, seems to proceed at an accelerating rate. It would be most interesting if those who have the opportunity would collect and thoroughly examine the composition of the deposit which collects on lamp bulbs, and thus throw valuable light on this interesting subject, and in addition, direct the steps of the pioneering lamp manufacturer into a track which is likely to lead to a material decrease in this unfortunate property of lamps. To carry out the work satisfactorily, it would be necessary to examine the deposit obtained from lamps from various sources, and then, should it prove to be other than pure carbon, to further ascertain, if possible, the treatment the respective filaments have been subjected to. The latter undertaking would, probably, be the more difficult of the two, considering the commercial interests at stake. It may be mentioned that the obscuring film is readily removed from the glass by means of a little warm caustic soda solution. Also the fact that the film is a sufficiently good conductor of electricity, even when faint, to become coated with copper when a piece of the glass is made the cathode in a copper plating bath. It is possibly due to this fact that an incandescent lamp acts as such an excellent condenser.

It is interesting to speculate as to how the obscuring matter, whatever it may be, finds its way from the filament to the glass. It is conceivable that there may be three methods by which the transfer can be effected: Firstly, by the direct formation of a vapour, as in the case of the vaporisation and sublimation of arsenic; secondly, by the solution to saturation of the matter in the residual gas and subsequent precipitation therefrom on the neighbouring cold surface, as instanced by the solution of water in warm air and its re-appearance on a window or other cool surface; thirdly, by the mechanical emission of solid particles. From a consideration of specimens of blackened lamps, it is difficult to determine which of these methods is the true one, or whether two or more methods combine to effect the transfer, because, in vacuo, the conditions of matter are so materially altered in so many essential details from those with which we are ordinarily familiar that arguing by analogy becomes impossible. But whether the transfer is effected by gaseous or solid particles, we may note certain very significant effects. The sharply defined uninterrupted circular line of slightly tinted glass, so distinctly visible by daylight in every well blackened lamp whose ∩-shaped filament is perfectly symmetrical, tells a peculiarly interesting tale. There can be no doubt that this half-coloured line is caused by the limb of the filament nearest the glass acting as a screen to the emissions of the more distant one. In other words, the projected particles of only one of the limbs can strike against the light coloured strip, because just there the further one is hidden, whereas in every other part of the bulb they can, and do, strike from both limbs, and consequently at all these other parts the glass is coloured to twice the depth of the screened portion. Another notable effect is that of the patchy, unequal blackening which occurs in the bulb of a lamp whose filament develops a bright spot, the glass in the neighbourhood of the spot being the darkest part. The same thing happens when the filament is bent so as to stand appreciably out of the centre of the bulb. From these observations it is perfectly clear that the matter, whether in the form of vapour or solid, is in the radiant condition, and that there is no turning of corners for it. The particles fly direct from the filament to the glass and there adhere to it and to one another as firmly as do the particles of copper on the cathode of an electro-plating arrangement; and further, they appear to follow the same law as light, in its property to decrease in intensity with the distance from the issuing point. It naturally follows from this consideration that for a given size of filament, the larger the bulb the less the amount of blackening, other considerations remaining the same.

As regards the remarkably coherent black film, it may be remarked that if it is built up by the accumulation of countless *solid particles* it would entail that carbon is possessed of far more of the soft, doughy property of lead or wax than one is apt to attribute to it. The principal causes assisting to bring about the cohesion, assuming this view to be correct, are, no doubt, the probable enormous velocity with which the particles travel, and the freedom from any foreign matter acting to interfere with the intimate contact of such particles as they collect.

Referring to the economic length of run that a lamp should have, it seems to the writer that any particular number of hours arrived at by calculation, can only hold good in a general sense, for the reason that lamps *do not* all blacken equally in the same time. Probably the actual run that lamps will have, in private houses at any rate, will be determined by the inconvenience experienced from an insufficiency of light rather than by any other consideration.

REPORT ON THE ELECTRICAL TRANSPORTATION SYSTEM OF THE NEW ENGLAND PORTELECTRIC COMPANY.

By FRANKLIN L. POPE

IN accordance with the request made by you* through Prof. Dolbear, I have made an examination of the system and experimental plant of the New England Portelectric Company, with a view to an expression of my opinion in reference to the results which may reasonably be expected to be attained in the commercial operation of a plant of this character when constructed on a scale sufficiently extensive to fully develop the capabilities of the invention. To this end I have observed and studied the operation of the existing experimental plant at Dorchester, Mass.,† and have taken notes of the results attained by it in actual operation. It did not seem necessary, for the purposes of the present investigation, to undertake a series of refined tests and measurements. Such a procedure would have consumed considerable time, and have been attended with unnecessary expense, while it could not after all have materially affected the value of the conclusions at which I have arrived. The measurements which have been made, though in a certain sense rough, are, nevertheless, sufficiently accurate and trustworthy to justify and support the conclusions which will be drawn from them.

Description of the Experimental Plant.—The experimental plant at Dorchester comprises an endless track, elevated upon a wooden trestle a few feet above the ground, 2,784 feet in circuit, consisting of one tangent of 588 feet, and another of 576 feet, united at their ends by two curves, one of which is 924 feet long and 282·5 feet radius, and the other 696 feet long and 234·4 feet radius. The track in the first tangent of 588 feet is level, while in other portions of the circuit are grades rising to a maximum of 4½ per cent., or 227 feet per mile.

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* This report is addressed to Mr. J. T. Williams, President of the New England Portelectric Company.

† For illustrations and full description of the experimental plant at Dorchester, see the *Electrical World*, May 4th, 1889, and October 18th, 1890, see also ELECTRICAL REVIEW, October 31st.

The track consists of an upper and a lower rail, formed of bar steel ¾-inch by ¼-inch, fastened by countersunk screws to stringers. The upper stringer is of wood, 2 inches square, and the lower also of wood, 2 inches broad by 4 inches deep. The upper rail is supported and braced at intervals of about 3 feet.

The carrier is virtually a hollow projectile of wrought iron, cylindrical in form, with ogival ends, the cylindrical portion being 8 feet long and 10 inches in diameter, the length 12 feet over all, and the weight approximately 500 lbs. It has capacity to contain, say, 10,000 letters, weighing, perhaps, 175 lbs. It is provided with two flanged wheels above, and two underneath, all of which, being fitted with ball bearings, revolve with very slight friction.

The propelling power is derived from a series of hollow helices of insulated copper wire, each of which encircles the track and carrier. These are fixed along the permanent way at intervals measuring 6 feet from centre to centre. Each helix is composed of 630 turns of No. 14 copper wire, in five layers, weighing about 20 lbs., and having a resistance of about 5 ohms. A contact wheel, mounted upon the carrier and running in contact with the upper track rail (which is divided into sections, and utilised as an electric conductor), connects the several helices in succession with the source of electricity as the carrier moves forward upon the track.

The electric current is supplied by a dynamo having a maximum capacity of about 8,000 watts, or a little over 10 H.P., driven by a steam engine rated at 10 H.P.

Experimental Data.—Experiments were first made to determine the maximum speed of carrier which could be obtained from the appliances in use at the time of inspection. This was found to be 2,784 feet in 56·5 seconds, or 49·3 feet per second, equal to 33·5 miles per hour.

The consumption of electric current, or rate of electric work while the carrier was in motion, could not be determined with strict accuracy, owing to the irregularity of the current, which caused the meters to fluctuate, but was approximately 200 volts and 38 ampères, equal to 7,600 watts. It may be stated with sufficient accuracy as between 9 and 10 electric H.P.

The tractive power of the helix upon the carrier was measured by an improvised dynamometer, the indications being read from a spring balance. The maximum tractive effort with a current of 10 ampères was found to be 80 lbs. The electrical force producing this magnetic traction was 6,300 ampère turns.

Experiments were made upon a section of level and straight track to determine the rate of acceleration, from which the average tractive force exerted by the helices upon the carrier while in motion may be deduced. The performance of the driving engine and dynamo were not very satisfactory upon this occasion; but, by combining the results of my own observations with the results of independent observations at different times, furnished by yourself and Prof. Dolbear, I think I may safely put the rate of acceleration as high as 4·5 feet per second. The force of traction required to produce this acceleration, with the carrier of 500 pounds' weight, is as follows:—

$500 \div 32{\cdot}17$ (acceleration of gravity) $= 15{\cdot}54 \times 4{\cdot}5 = 69{\cdot}93$ (say 70).

Efficiency of the Apparatus.—The rate of acceleration with a given tractive effort becomes less and less as the velocity increases, until it is balanced by the constantly increasing resistance, when the motion becomes practically uniform. A tractive effort of 70 lbs., exerted upon the carrier moving at the rate of 50 feet per second, requires the expenditure of 6·3 H.P., or 4,712 watts. As the average electrical energy supplied appeared to represent something like 8,000 watts, the efficiency of the helices and carrier, considered as an electric motor, may be estimated at about 60 per cent., which figure agrees very well with other determinations of solenoid magnets.

Improvement of the System.—It is evident that in order to render the system of commercial value, the speed of the carrier must be greatly increased beyond that which has been found to be attainable with the existing experimental plant. It remains to consider the practicability of accomplishing this without entailing an inordinate cost of either installation or working.

Several improvements tending to aid in the attainment of this result suggest themselves, as follows:—

1. Increasing the electrical efficiency of the helices.
2. Reducing the mechanical resistance to the movement of the carrier.
3. Increasing the absolute amount of electrical energy supplied by the generators to the helices.

I will consider these points in order.

There is some loss of efficiency, but not a very large loss, due to the space permitted between the inner surface of the helices and the exterior of the carrier. This is largely an allowance made to facilitate the passing of curves, there being one of only 234 feet radius. I would not advise the adoption, on a commercial line, of curves of less than 1,000 feet radius, in which case the clearance might be considerably reduced, to the advantage of the electrical efficiency.

The principal loss in electrical efficiency, in my opinion, arises from the inductive currents set up in each helix, as the contact is broken after the passage of the carrier. This action not only wastes energy but rapidly burns away the metal of the contact wheels and rails.

It appears to me that this evil might be largely, if not wholly, obviated by the expedient of breaking the circuit a little earlier than is now done, and simultaneously closing the circuit of the coil on itself, thus compelling the induction current to *do work* in propelling the carriage. I have taken the liberty to submit herewith a plan for effecting this. The objection to this arrangement is in the short circuiting of the dynamo for an instant at each break, but not necessarily for more than 0·002 second. I would strongly advise that this be tried.

It is very apparent that the principal obstacle to the attainment of high speed in the present plant is due to the excessive mechanical resistance, arising from the unevenness, and especially from the lack of rigidity of the track. The small radius of the curves also adds materially to the resistance. The amount of noise made by the carrier when running at its highest speed is sufficient evidence of this (for noise always means waste of power), but a consideration of the conditions brings out the fact very prominently.

The resistance of the air to a carrier of this form and dimensions, at a speed of 50 feet per second, is less than 1 lb., and may almost be neglected. Dr. Dudley has recently stated that on the best modern railroads the resistance of trains running at 50 to 60 miles per hour, a rate considerably higher than that of the carrier when observed by me, the total resistance to traction was only from 10 to 12 lbs. per ton. Hence it would seem that it ought to be entirely practicable to reduce the total resistance opposing the movement of the carrier, at a speed of, say, 30 feet per second, down to something like 5 lbs., certainly not more than one-tenth of what it now is.

All experimental knowledge justifies the assumption that, with a track perfectly smooth and rigid, or as nearly so as the mechanical skill of the day is capable of producing, the resistance will not at the utmost increase in a ratio more rapid than that of the speed, in which case a speed of 150 miles per hour, or 220 feet per second, should only give a mechanical resistance of 9 lbs., to which must be added the atmospheric resistance, which, according to the accepted formula of Bashforth, would amount to 8·69 lbs. in addition, or a total of, say, 18 lbs. To overcome this would require an electrical rate of work equal approximately to 7 H.P.

$18 \times 220 = 4{,}360$ (foot-pounds) $\div 550 = 7 +$ H.P.

It would seem, therefore, with a proper track, that the tractive power of such helices as are now in use, when supplied with electric energy of no greater value than that now employed, should be sufficient to propel the carrier at the rate of 150 miles per hour.

Elements of Cost of Electrical Plant.—Upon the assumption, therefore, that the tractive power of the helices now in use will be sufficient, under favourable mechanical conditions, to propel the carrier at an average velocity of 150 miles per hour, the next question for consideration is the quantity and cost of the copper wire necessary for the purpose.

In the experimental plant the helices are composed of 630 turns of No. 14 insulated copper wire, and weigh approximately 20 lbs. each. They are placed 6 feet apart from centre to centre. There are, therefore, 880 helices, and

17,600 lbs. of insulated wire per mile in the helices, in addition to that in the main conductors.

I have given much consideration to the possibility of reducing the amount of copper required. The computation already made shows that an average tractive effort of 7 H.P. is required to maintain a speed of 150 miles per hour, and this must necessarily, under all circumstances, be proportionate to the square of the ampère turns. It follows from this that a certain number of *ampère turns per mile* will be required in any case, wholly irrespective of the length of the intervals between the helices; they may be nearer together with less turns on each one, or farther apart with more turns on each one. From this, furthermore, follows the apparently singular circumstance that the *weight of copper* required in each coil to do the required work *does not in the least depend upon the potential of the exciting current*, and hence cannot be diminished by increasing the potential. Economy in conducting material can only be effected by forcing as large a volume of current as practicable to pass per unit of cross-section of copper.

As each coil is ordinarily in circuit for only a fraction of a second at a time, it is evident that a volume of current per unit of sectional area may be used with impunity in this case which would be wholly inadmissible under ordinary conditions.

In order to determine this point, experiments have been made with insulated copper wires under different conditions of current. It was found, as a result of a number of trials, that a copper wire having a textile insulation, when coiled into a helix of several layers, requires a cross-section of about 50 circular mils. per ampère, in order not to carbonise the insulation after 15 to 20 seconds' time.

The present coil is of No. 14 wire, which has an area of 4,107 circular mils.; this multiplied by the number of convolutions (630) gives a total sectional area of copper of 2,587,410 circular mils.

The helices and current used in the experimental plant may be taken as equal to 25,000 ampère-turns per helix. The magnetising effect of this is equivalent to that of 25,000 ampères traversing a single turn. Therefore the proposed coil must have an aggregate cross-section of at least 1,250,000 circular mils. It would seem practicable, therefore, to reduce the weight of copper in the helices in the proportion of 2,587,410 to 1,250,000, that is, from 17,600 to about 8,500 lbs. per statute mile of track.

In this connection a suggestion is offered which may be of value. It is known to be entirely practicable to construct helices from naked copper wire of any required thickness, wound in the helix by machinery, so as to leave an insulating air space between the convolutions, and it is recommended that experiments be made with a coil of this kind having its layers separated by asbestos paper or mica. With such a coil it is reasonable to expect that the volume of current per unit of cross section could be carried considerably beyond the point which has been assumed, with a corresponding gain in economy of copper.

A No. 4 wire having an area of 41,742 circular mils., will deliver a current of 7·1 ampères, at a distance of 20 miles or 105,600 feet, with a drop in potential of 500 volts. If the initial potential is 1,500, and at terminals of the most distant coil 1,000, the mean loss of energy in the line between the initial point and the extreme end will be 25 per cent.

A No. 4 wire (double) weighs 1,332 lbs. per mile.

This will make the total cost of copper wire for line and coils about as follows :—

1,330 lbs. copper for line, at 16 cents ...	$212.80
8,500 „ „ coils, at 23 „ ...	1,955.00
	$2,167.80

The provision for power required to propel the carrier at the assumed rate may be taken at 1,500 volts and 7 ampéres per 40 miles of single track, or about 0·33 H.P. of *generating capacity* per mile. This may be estimated, including steam plant and buildings, at $125 per H.P., or, say, $45 per mile.

So many considerations enter into the question of the total cost of a commercial line which are dependent upon the frequency with which carriers are to be sent—whether a double track will be necessary on any portion or the whole of the route, and many other like considerations—that I am unable to venture even upon an approximate estimate. I have, however, furnished the best attainable data from which this may be computed.

The question of the most economical interval between the stations is a very important one. I have assumed 40 miles, which I believe to be entirely practicable. It may be found feasible and economical to materially increase this interval. It is a question which is solely influenced by the potential which it is found practicable to employ.

The actual cost of the electric power required to propel the carrier at the assumed rate of 150 miles per hour may fairly be taken at 5 cents per H.P. hour, including cost of attendance at stations. The mere cost *of power* for propelling a carrier from Boston to New York would therefore not exceed 75 cents per trip.

General Conclusions.—The results of this investigation have convinced me that efforts for increasing the efficiency and economy of the Portelectric system should henceforth be directed mainly to the improvement of the track. The electrical portion of the system as exhibited in the experimental plant is judiciously planned, and I can suggest no material improvement other than those hereinbefore alluded to, viz., the short circuiting of the coils and the use of naked wire and asbestos in the coils.

The opinion has recently been publicly expressed by an electrical engineer of reputation and experience that no automatic system of high-speed service for either passengers, freight or mail can ever come to a commercial issue. No arguments were adduced in support of this dictum, and, for my own part, I am wholly unable to see any good reason why this assertion should have been made in such an unqualified and authoritative manner. The experiments conducted under my direction at Dorchester are, in my own opinion, sufficient to prove the contrary. There can be no question but that a carrier can be automatically started and maintained at high speed for any reasonable distance, and for any reasonable length of time; the only question is as to stopping it with facility and safety at desired points. This may be effected, as was experimentally demonstrated at Dorchester several times in succession in my presence, by arranging a number of the ordinary propelling coils, so that their successive tractive effort is exerted upon the carrier in the reverse direction, producing an exceedingly powerful retarding effort by the most invisible and gentle means. By this means a carrier travelling at the rate of 150 miles per hour may readily be brought to a stand without shock, jar, or strain within a few hundred feet. Such an apparatus may be, arranged at any point on the line, at an inconsiderable expense, and used or not as desired.

A straight track of 3,000 or 4,000 feet, provided with arrangements to stop the carrier by magnetic attraction, would, in my opinion, enable every question as to the capabilities of the system to be thoroughly determined by actual experiment. I see no reason why the speed should necessarily be limited to 150 miles per hour, but have taken that speed as one which is high enough to be of great commercial value, and yet low enough to be susceptible of having its conditions calculated from known experimental data. That this speed can be attained with a carrier of the dimensions of that now in use in the experimental plant, with not more than half the weight of copper per mile there used, and with no greater expenditure of power per mile run, I have every reason to feel confident, from the considerations which have been adduced.

THE FRENCH TELEPHONE SUBSCRIBERS AND THE STATE.

SINCE the French telephones were taken over by the State nearly two years since, there has been, as we have stated on different occasions, friction between the Government and its clients, and now it has culminated, as announced by us in a leaderette of last week, in a very high-handed proceeding on the part of the former. A few hours after the receipt by the subscribers of the circular which we printed in the REVIEW of May 29th, by which they were ordered, within 15 days, to come to an understanding with the General Telephone Company for the purchase of their apparatus, of which by their old contract with the company

(Article 2) they were only users and not owners, they received another circular, this time from the company. This was at once the confirmation and execution of that sent by M. de Selves in agreement with the company, and ran as follows :—

"Conformably to the circular dated April 21st, which has been sent you by the Administration of Posts and Telegraphs, we have the honour to send you herewith an invoice of the apparatus forming your subscriber's post to the network of ———, which have been left at your disposal since January 1st, 1890, the date at which your new subscription policy to the State network came into force. In a few days we shall call upon you, in order to be paid the enclosed account. Within 15 days from the date of presentation, the amount of our account not being paid, we shall be obliged to make it known to the Administration of Posts and Telegraphs, which you will find foreseen in the case in the last paragraph of the circular, of which we enclose a copy, in case the original should not have reached you."

In these invoices the indebtedness of each subscriber is determined according to the number and nature of the telephone posts, which has to be paid by those purchasing at the rate fixed. The circular and invoice were necessarily only addressed to those whose subscription to the telephone was anterior to September 1st, 1889, the date at which the measure came into force which conceded henceforth to the State the working of the monopoly of the whole telephonic network, which it had purchased for a sum of ten million francs. Those who have subscribed since that date have nothing to fear from the company, since their installations were made according to Article 5 of the new State subscription policies. The old subscribers, however, are not so well off. During the whole of last week the Telephone Company demanded payment of their account, and to those who had not paid a further 15 days' grace will be allowed. When that period has elapsed they will be prosecuted, and the General Telephone Company will request the Posts and Telegraphs to suspend their communication. Quite recently the company upheld before one of the Courts that it alone had the right to use, for the construction of telephonic apparatus, the Edison induction coil, of which it had bought the patent for France. It won the case, and, in executing the judgment, it seized all the apparatus made on that principle elsewhere than in its workshops. There are doubtless many apparatus which are not supplied with the Edison coil which have escaped seizure, but they are only of use for short distance communications. The result of this judgment is, that if the State possesses the monopoly of the telephone network, the General Telephone Company alone has the exclusive monopoly of constructing telephone posts.

On their part the subscribers formed a committee, which body issued the following circular to the subscribers generally :—"Your service is assured by contract with the State, and it alone can introduce any change whatever therein. If the State enter your premises to suspend your service it exceeds its rights ; further, it would suspend by this fact its collection till you see your service reinstalled by it. As to the General Telephone Company, it has no more right than any other citizen to enter your premises, even to take possession of anything belonging to it. To enforce its claim, it can only employ the means of law and custom, in the form and with the delay entailed thereby. We are of opinion that, in the present case, it can only act against you by the interference of the State." This again was met by another circular from the company, as follows : "After the discussion in the Chamber on Tuesday on the subject of the circular of the Posts and Telegraphs, the General Telephone Company thinks it should offer the public the following explanations, and that without departing from the attitude which it has not ceased to observe since the State entered into possession of its property. Its networks comprised lines running from the central offices to the subscriber's domicile. For 18 months the Administration has worked this network without having paid for it. On the seizure of the *matériel*, the Minister of Posts and Telegraphs included in the objects seized the apparatus found at the subscribers' premises, and an expert was appointed by the Prefecture to make an inventory of them. In the course of the litigation since entered into against the State, the Administration, as was honestly recognised by the Minister in the tribune, recently proposed to the company to withdraw the apparatus question from the litigation ; it placed the subscribers under the necessity of paying the amount due to the company since its dispossession. One could but yield to this demand. Since that, the Minister has taken a contrary decision ; the Telephone Company does not intend to discuss that change of attitude here. After an exchange of views with the Administration, it asked those in possession of the apparatus for the sum which, according to its view, should have been paid it in September, 1889, and which it still claims before the experts, neither more nor less. These explanations are the only answer which the General Telephone Company intends to make to the injurious and calumnious imputations cast at it in the tribune by a deputy."

Le Temps gives the following account of the debate referred to in the foregoing circular : The Chamber was occupied with a very curious question concerning the working of the telephones. We have not forgotten the old circular which M. de Selves addressed, on April 21st, to the old subscribers of the General Telephone Company. These subscribers were told that they would have to come to an understanding with the company for the purchase of their apparatus. "The company would be within its right," added M. de Selves, "to remove your apparatus within a period not exceeding 15 days, and, consequently, your communication with the network would be suspended till further notice." The effect caused by this unexpected notice can be imagined. It could not fail to have its influence on the Chamber, hence the question put to the Minister of Commerce. How has the Posts and Telegraphs arrived at that position which constitutes a threat to interrupt the service of the old telephone subscribers ? Since September 1st, 1889, they have enjoyed the peaceable use of their apparatus. They unquestionably owe the sum, but to whom ? When the State took the place of the General Telephone Company, the latter claimed this payment ; it has declared itself, on this account, a creditor of the State for a sum of 2,700,000 francs. The Administration has contested the principle of this debt, and has submitted the affair to competent tribunals, and the matter is pending. It was then that the Administration of Posts and Telegraphs had an inspiration of genius. Consulting itself, it said : "If I obliged the old subscribers to free themselves with the telephone company, by frightening them with the prospect of an immediate suppression of their service, they would doubtless pay the company, a payment which I will not or cannot make. The question pending before the tribunals would be settled. My case, were it bad in law, would be won in fact." This combination appeared less ingenious to the Chamber than it had to the Posts and Telegraphs officials. M. Jules Roche did his best to explain the circular of M. de Selves, but the conclusion of his speech was neatly summarised by the President of the Chamber : "The Minister has told you, in the best Parliamentary language, that the circular was nul." As these words were received with cheers, M. Floquet said : "As far as concerns the measures of execution announced, be it understood." To which M. Peytral added : "It is well understood that the communication will not be cut ; that is the only declaration which we wished to have ; we have it, we are satisfied." By the incident which has occurred, it will be seen with what lightness the taking over of the telephones has been carried out.

Writing later, the same contemporary says :—From the particulars we have given on this subject, it will be seen how singular was the position of the old telephone subscribers, since the circular of M. de Selves and that of the company make it necessary for them to pay, within 15 days, for the apparatus installed in their houses, or to purchase others which can only be had from the workshops of the old company. This position is improving. The Edison coil, which was the *sine quâ non* condition of the working of the telephone posts now established at subscribers' premises, will shortly be replaced by the invention of new apparatus which will work by a different process to that of the induction coil. The inventor is M. Roulez, the well-known amateur fencer, to whom the riband of the Legion of Honour was granted some time since for having supplied the State with a microphone —of the Edison pattern, it is true, but showing considerable improvements over apparatus of that kind already in existence. Yesterday afternoon M. Jules Roche, in the presence of M. Baron, director of the electric working, treated with

M. Roulez for the adoption of his apparatus. The greatest mystery was recommended to the Ministry as to the affair, on account of the offers which had already been made to M. Roulez by the General Telephone Company for the purchase of his patent. By the terms of the agreement entered into between M. Roulez and M. Roche, the Direction of Posts and Telegraphs will alone have the right to deliver licences to the constructors. The new apparatus will cost 100 francs (£4), and M. Roulez will take 20 francs for each apparatus sold. Still, it cannot be concealed from the Posts and Telegraphs that M. Roulez's apparatus will only with difficulty fill the place of the apparatus of the old company for long-distance communications. Three telephone posts on the Roulez system—the only ones constructed up till now—have been tried. If these trials of the new invention gave excellent results for short distance communications, those obtained for long distance apparatus were less satisfactory. As to the manufacture of the apparatus, the Administration hopes to carry it on very actively. This morning a man called at the Rue de Grenelle and stated that within a fortnight he was prepared to supply about 1,000. This morning also we have seen M. Roulez, who confirmed the foregoing particulars. Roulez, who is a devoted scientist, explained to us his system, consisting in replacing the induction coil in the receiving apparatus, the technical details of which are unfortunately too abstruse for reproduction here.

Since the above was written, the Direction of Posts and Telegraphs has addressed the following circular to the telephone subscribers :—"In addressing to you the circular letter of April 21st, the Administration thought you would come to an arrangement for the purchase of the telephonic apparatus of your office with the General Telephone Company, which had supplied it. This not having been done, things remain stationary till the issue of the action pending between the Administration and that company is known. But I beg you not to lose sight of the fact that it is necessary to regulate your position, which is not conformable to the agreements you have entered into by signing with the State your subscription policy, Article 5 of which runs as follows: The *matériel* of the line and the generators of electricity are supplied by the State. The different apparatus composing a telephonic post and the accessories required by the subscriber are supplied by him. They are to be chosen among the types indicated by the Administration, and must be renewed when they have become unfit for the service. These apparatus before being placed, must be verified and accepted by the agents of the Administration." The General Telephone Company has also added its quota, as it states that it thinks it necessary to inform the public that, contrary to the interested rumour which has been spread, it has never raised the price of its apparatus and has no intention of doing so, despite the judgment affirming the validity of its patents.

LONDON COUNTY COUNCIL.

At the last weekly meeting held on Tuesday, the following report of the Highways Committee was presented:—

Electric Lighting Provisional Orders, 1891.

We have to report that the Board of Trade has forwarded a copy of the City of London Electric Lighting (Brush) Order, 1891, in the form in which it has been granted; and that in this the amendment asked for by the council has been inserted.

The Board of Trade has introduced a Bill into Parliament to confirm the Westminster, Islington, Wandsworth, Camberwell, Southwark, Woolwich, City of London (Brush), St. Luke's, Middlesex, Clerkenwell, and St. Luke's, Chelsea, provisional orders. We recommend that it be referred to the Parliamentary Committee to take any steps which may be necessary on behalf of the council with reference to the Bill.

North London Electric Supply Order, 1890.

We have had before us a letter from the Board of Trade, forwarding a copy of correspondence between the board, the vestry of Islington, and the undertakers under this order with reference to the non-compliance by the undertakers with the provisions of section 7 of the order, requiring them to deposit the sum of £1,000, and to satisfy the board that they are in a position to fulfil the duties and obligations imposed by the order. The board states that, subject to any representations that the council may make, it proposes to revoke the order. We have informed the Board of Trade that the council has no observations to offer with reference to the proposed revocation of the order, and leaves the matter to be determined by the board.

Notices under Electric Lighting Orders and Acts.

The council on the 12th of May authorised us to deal with any matter within the scope of our reference which might require, either on that day or during the Whitsuntide vacation, to be dealt with immediately on behalf of the council. Acting under this authority, we have considered the undermentioned notices under the Electric Lighting Orders and Acts, and have, subject to the conditions stated below in each case, sanctioned on behalf of the council the works referred to therein:—

Notices.

Notice, dated 4th May, 1891, from the Notting Hill Electric Lighting Company, of intention to lay mains on the south side of High Street, Notting Hill, from the corner of Campden Hill Road to No. 105, High Street (1 plan, No. 40a).

Conditions Attached to Sanction of Works.—That the company do give two days' notice to the council's chief engineer before commencing the work; that the cover stones of the culvert shall not be less than 2 inches thick; and that, where the culvert crosses the carriageway, there shall be at least 9 inches' thickness of Portland cement concrete above the coverstones of the culvert in addition to the road material.

Notice, dated 28th April, 1891, from the Electricity Supply Corporation, for the placing of mains in the subway in Charing Cross Road from the southern end to Cranbourne Street (1 plan). [Permission had previously been given by the council for the placing of this company's mains in the subway south of Green Street.]

Conditions.—That the positions to be occupied by the mains in the subway shall be subject to the approval of the chief engineer of the council, and that the work of placing them shall be carried out to his satisfaction. Formal notice has been given to the company to place the mains for Charing Cross Road, referred to in the notice dated 28th April, 1891, in the subway of that thoroughfare.

Notice from the same company, dated 8th May, 1891, of intention to lay mains from a box in the carriage-way of the Strand to the corner of, and along Duncannon Street, to Trafalgar Square (1 plan).

Conditions.—That the company do give two days' notice to the council's chief engineer before the works are commenced; that the mains be laid under the footways wherever it is found practicable to do so; that the concrete floor of the road boxes be made 9 inches thick; that the York stone at the top be 4 inches thick; that the longitudinal girders in all the boxes be laid on 3-inch stone templates the full thickness of the brickwork; and that the work shall be completed within the shortest time possible.

We recommend that the council do ratify the action taken by us with reference to the matters above specified.

We have also to report the receipt of the undermentioned notices from the London Electric Supply Corporation, given in accordance with the resolution of the council, to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid—

1st May, 1891—To 181, 213, 229 and 235, Oxford Street.
5th " " 5, Foubert's Place and 35, Haymarket.
9th " " 22, Cockspur Street.
11th " " 169, New Bond Street.
11th " " 5, 6, 7 and 35, Haymarket.

Subways.

The National Telephone Company has applied for permission to use a space, having a sectional area equal to one square foot, in the council's subways in the Charing Cross Road and Shaftesbury Avenue respectively, such space to be occupied by the company's cables. A similar request with reference to the Victoria Embankment and the Queen Victoria Street subways was granted by the council on 24th March last, the company having agreed to pay rent in accordance with the scale recently adopted by the council. The rent, according to this scale, in respect of the subways referred to in the present application, is £26 a year for each subway. We have, on behalf of the council, acceded to this application, upon condition that the company do enter into an agreement, to be prepared by the council's solicitor, to pay a rent of £52 a year, being £26 in respect of each of the subways referred to in the application; that the positions to be occupied by the company's cables in the subways be approved by the chief engineer of the council; that all cables and wires of the company now in the subway be removed into the space specified, and that all work connected with the subway shall be carried out to his satisfaction and at the cost of the company; and that proper earth connections be provided for the lead-covered cables. We recommend that the course taken by us be approved.

PARLIAMENTARY NOTES.

On the House going into Supply,

Mr. **Pickersgill** said that he had seen that it was proposed to close the British Museum from the 1st of June to the 4th of July for the purpose of making some alteration in the electric lighting plant. This seemed to him to be somewhat a long time, and he would be glad to elicit some information on the subject as to who originally installed the electric lighting, in what respect it had been found deficient, and what was the character and probable expense of the operations.

Mr. Jackson said that he was afraid that he was not able to give the information required, as he was not aware of the circumstances. He had always understood that the electric lighting of the Museum was very satisfactory, and had been very well done. He could quite imagine the authorities taking advantage of the long days for making any necessary alterations. The installation had been done under the superintendence of Mr. Preece, the electrician to the Post Office.

The Royal College of Science.

In the House of Commons on Thursday night,

Dr. Farquharson asked the Chancellor of the Exchequer whether any correspondence between the Treasury and the Science and Art Department existed relating to the proposed grant for a new art gallery on land bought for scientific purposes, and on which buildings in use by the students of the Royal College of Science already existed.

The Chancellor of the Exchequer: In reply to the hon. member, I have to state that no such correspondence exists.

Dr. Farquharson: May I ask whether the House is to understand that in a matter of the highest importance, affecting the teaching of science in the Royal College of Science at South Kensington, no opportunity is to be given to the scientific officers of the Science and Art Department to express their views?

The Chancellor of the Exchequer: That is not the question of the hon. member. His question was whether there was any correspondence on the subject. If the hon. member will ask for any information, I will endeavour to give it. There has been no correspondence, but I may say that the representatives of the Department were present when the ground was examined and the matter was gone into.

Electric Lighting Provisional Orders Bill (No. 7).

On the order for the second reading of this Bill, relating to the town of Killarney,

Mr. A. O'Connor moved its rejection, on the ground that the meeting of the Town Commissioners which approved of the scheme was not regularly summoned.

Sir M. Hicks-Beach said that there would be a much greater demand for the electric light in Killarney than in an ordinary Irish country town. The real opposition to the Bill came not from the inhabitants of the town but from the gas company. He had never before heard it suggested that the meeting of the Town Commissioners was irregularly summoned; but if any further enquiry were necessary a Select Committee was the proper tribunal to conduct such enquiry.

The Bill was then read a second time.

Limited Liability Companies.

Mr. Leng asked the Attorney-General whether limited liability companies in the United Kingdom could obtain, until recently, from Messrs. Eyre and Spottiswoode, the Queen's printers, certified copies of the Companies Acts, for production in foreign courts of law, without any charge for the certificate; whether the granting of such certificates had been subjected to a charge, by an official in the Parliament office, of a guinea for certifying each Act, and 10s. 6d. for every 100 folios, bringing up the total for a set of the Companies Acts to about £25; whether there was any reason for imposing this new charge on public companies; whether such fees were excessive; and whether he would give instructions for a more moderate scale of fees to be adopted.

The Attorney-General: The answer to the first paragraph of the question is in the affirmative. With reference to the second paragraph, the change in the practice was instituted because it was considered that, inasmuch as the Lord Chancellor has to affix the Great Seal to the Act in question, this step should only be taken upon the certificate of the Clerk of Parliaments, who is the official custodian. The fees are paid to the Treasury, and no part is paid to, or are the fees any perquisite of the gentleman named in the question. So far as my opinion is of value, I do not see that the fees are in any way excessive. There is no obligation to obtain certified copies. Any foreign Court may, if it thinks fit, be satisfied with a copy printed by the Queen's printers, in the same way as our Courts accept an Act so printed.

LEGAL.

Mangan v. Metropolitan Electric Supply Company.—(Before Lords Justices Lindley, Bowen, and Fry.) This action was brought in the Chancery Division last week, claiming an injunction to restrain the continuance of an alleged nuisance arising from the noise produced by the working of electric machinery in Manchester-street, Manchester Square. The plaintiff also claims damages. The plaintiff applied for and obtained an interlocutory injunction to a limited extent, but a second application for an injunction was refused. The plaintiff afterwards applied by summons in Chambers for an order that the action should be transferred to the Queen's Bench Division and be tried with a special jury. On this summons Mr. Justice North made an order for transfer, and he refused a subsequent motion by the defendants to rescind the order. The defendants appealed.

Mr. Napier Higgins, Q.C., and Mr. J. G. Butcher were for the appellants.

The Court suggested that the best course would be to refer the action to an official referee for trial.

The defendants' counsel were willing to consent to this course, but Mr. Cozens-Hardy, Q.C., who (with Mr. Percy Gye) appeared for the plaintiff, declined to consent.

The Court dismissed the appeal, but reserved the question of the costs until after the trial.

Lord Justice Lindley said that in substance the Court was asked to order Mr. Justice North to try the action himself after he had come to the conclusion that it would be better tried with a jury. The action was an ordinary one for a nuisance, brought in the Chancery Division. By means of the two motions for an injunction the learned Judge had acquired a knowledge of the case. The plaintiff originally selected the Chancery Division, but he afterwards thought a jury would be a better tribunal for the trial than a judge alone. Mr. Justice North transferred the action to the Queen's Bench Division in order that it might be tried with a jury. This Court was asked to set aside the order on the ground that the learned Judge in exercising his discretion had attached undue weight to the difficulty of assessing the damages. It was, however, obvious from his judgment that Mr. Justice North had not acted upon any general rule, but had fully considered the particular circumstances of the case. His Lordship did not think that this Court could differ from him, or that it ought to differ, unless it thought that his order would amount to a miscarriage of justice. The case of "Jenkins *v.* Bushby" (1891, 1 Ch., 484, *The Times* Law Reports, vol. 7, p. 227), which had been relied on for the defendants, was a peculiar one. It was urged there that there would be a miscarriage of justice unless there could be a view of the property in question, and on this ground the Court of Appeal overruled the exercise of discretion by Mr. Justice Stirling, and ordered a trial with a jury. It was true that Rule 4 of Order 50 of the Rules of Court enabled a judge to have a view of the property himself, but in that case this would have been practically impossible by reason of the distance of the *locus in quo* from the railway station, and the Court of Appeal thought it essential for the purposes of justice that there should be a view of the property. There was nothing of that kind in the present case. The appeal would be dismissed, but the costs would be reserved until after the trial. If the Judge should come to the conclusion that the action ought to be referred, this might influence the Court in deciding how the costs ought to be borne.

Lord Justice Bowen and Lord Justice Fry concurred.

Hampton and Sons v. the London Electric Supply Corporation, Limited.—This case came before the Lord Chief Justice of England and a London special jury on Thursday. The plaintiffs sued the defendants for £5,000 damages for their neglect to supply electric light to the extent of 600 lights to the plaintiffs' premises, situated in Pall Mall, in alleged breach of an agreement entered into between the parties at the end of the summer of 1888. There was a considerable conflict as to what was the actual contract (if any) to be derived from the correspondence which had passed between the parties, and as to what expenditure and loss of profits on the part of the plaintiffs could be in any way attributed to the defendants' failure to supply the light. It appeared that the plaintiffs made certain structural alterations in their premises so as to adapt them for the electric light, and also erected the necessary wires and other accessories, so as to meet the requirements of the defendant company. The defendants supplied converters, and appear to have turned on the current once, but never to have done anything further towards lighting the plaintiffs' premises. The plaintiffs were consequently put to great inconvenience, their premises being often left during the months of December to March in partial or complete darkness; and it was necessary to have recourse to less effectual means of lighting the several shops and show rooms. Evidence was given that, whereas the plaintiffs' sales for the four months in question in a previous year amounted to £54,998 7s. 5½d., and in the succeeding year to £56,869 2s. 0½d., in the year in question they only amounted to £36,041 18s. 11d., and this decrease the plaintiffs largely, if not entirely, attributed to the gloom in which their premises were left. Ultimately the plaintiffs obtained a supply of light from the Metropolitan Electric Supply Company, at a charge of 25s. a year per light, with the right to use as much light as they pleased during certain fixed hours of each day, whereas the defendants' charge was 7½d. per unit, with the addition of a charge for meter, switches, &c., which, according to the plaintiffs' view, would only have amounted to 12s. 6d. per light per annum. On behalf of the defendants it was contended that there never was any contract, and consequently that there was no liability at all upon them to supply the light, nor would there have been upon the plaintiffs to take it; and, further, that if the plaintiffs were in any way injured by the failure of the light, the damages claimed were too remote for the defendants to be held liable for them. The defendants, whilst denying liability, had paid £75 into court as sufficient to satisfy any claim which the plaintiffs might have against them.

Mr. Jelf, Q.C., and Mr. Lee Roberts appeared for the plaintiffs; Mr. Moulton, Q.C., and Mr. Pyke for the defendants.

His Lordship, having summed up the case in great detail, left four questions to the jury, viz.:—(1) Was there a contract? (2) If so, what was the contract? (3) Has the contract been broken? (4) And, if so, what damages ought the plaintiffs to recover?

The jury returned a verdict that there was a contract to supply electric current up to 600 lights on the terms contained in the application form, and gave the plaintiffs £175 damages beyond the amount paid into court.

His Lordship, having previously intimated what his own view of the case was, said that he would give judgment on the following morning.

On Friday morning plaintiffs' counsel applied for judgment.

The Lord Chief Justice said that he could see no evidence of a contract, and should therefore enter judgment for the defendants with costs.

It was intimated that there would be an appeal, and execution was stayed.

TESLA'S EXPERIMENTS WITH ALTERNATING CURRENTS OF HIGH FREQUENCY.

The Wednesday evening session (May 20th) of the American Institute of Electrical Engineers was held in Prof. Dwight's room, Columbia College, and will long be remembered by those present, not only on account of the brilliant experiments shown, but also for the many possibilities which it suggested in the development of the artificial illumination of the future. For the purpose of his experiments Mr. Tesla employed the alternating machine with 400 poles, which, when run at full speed, permitted him to obtain 20,000 alternations per second. The currents of this machine in all of Mr. Tesla's experiments were first run through a condenser in order to avoid the possibility of injury to the machine. The machine itself was set up in the electrical workshop of the college and was driven by an electric motor, the speed of which could be varied by a switch on the lecture platform.

Mr. Tesla introduced his subject by the remark that modern science has been able to make rapid strides by the recognition of ether as the medium of transmission of vibrations of various forms which manifest themselves to our senses. We are therefore able now to see things in a different light than was formerly the case, and being tolerably well able to explain them, the truth cannot be hidden much longer. The answer to the question, "What is Electricity?" we were not yet prepared to give. We were justified in assuming, however, that electric phenomena are ether phenomena, and we may consider the phenomena of static electricity as phenomena of ether under strain, and those of dynamic electricity and electro-magnetism as phenomena of ether in motion.

Mr. Tesla, while expressing the highest consideration for the work of Dr. Lodge, was not in entire accord with the views advanced by him, which he considered to be more of the nature of ingenious explanations than of a probable theory, Mr. Tesla contending that there can be no two electricities.

Alluding further to the electro-magnetic theory of light, and to the Hertz experiments and those of Dr. Lodge and their application to the production of an efficient source of light, Mr. Tesla considered the electro-magnetic waves as unavailable for the production of luminous effects, for the reason that long before we could reach the necessary frequency, the conductor would become opaque to the passage of the waves. Mr. Tesla thought that electro-magnetic waves, unless they have the frequency of true light waves, cannot produce luminous effects. Not so, however, with the electrostatic waves or thrusts. These, no matter what their frequency, can excite luminous radiation. He reasoned that the static effects in the Hertz and Lodge experiments were excessively small, due to the fact that they were produced in a practically closed coil, the spark acting as a bridge, making the coil practically continuous, and depressing the potential. To obtain the desired difference of potential, we must work with an open circuit generator of high potential of high frequency to enhance the electrostatic effects, and it was the recognition of this fact which led Mr. Tesla to the results he showed.

In carrying out this idea of obtaining enormous differences of potential, Mr. Tesla at once encountered the difficulty of obtaining the requisite insulation for the induction coil employed by him. His experience demonstrated that what we consider the best insulators, such as glass and rubber, are inferior to others, not formerly so considered, such as oil and wax. Mr. Tesla then started a spark coil in action, the primary of which was in connection with his alternator, which was speeded to give from 10,000 to 11,000 alternations per second. The coil emitted a clear note, which rose as the number of alternations was increased. As the discharges took place between the terminals of the coil, an exhausted Geissler tube, held in proximity to the discharge, did not light, but upon blowing out the arc, the tube lighted up, which was due to the rise of potential caused by the rupture of the arc. This effect Mr. Tesla considered as purely electrostatic.

Mr. Tesla then showed the influence of insulated bodies having considerable size upon the spark length, demonstrating the effect of capacity upon the nature of the discharge. Thus, when we attach an insulated body to the terminal of the coil, the potential may be raised or lowered. He showed this by wrapping an insulated wire of about 1 foot in length about one terminal of the coil, and touching the other terminal with a brass sphere held in the hand; under these conditions streams of light emanated from all sides of the wire. When the sphere was removed, however, the streams disappeared almost entirely. He then cut off the wire in successive lengths, and the stream discharges became more marked and brilliant. He then attached a fine platinum wire to the terminal, which also showed the streams to a remarkable degree, and kept up a continuous vibration to and fro. He also showed a pinwheel effect, the wheel being rapidly rotated, with streams issuing from the two points. Another experiment consisted in attaching two spheres of about 4 inches diameter to the terminals. The spark passes first between the two points nearest to each other on the spheres, then works up toward their tops, is extinguished and is re-established at the first point, this being continuously repeated. The neighbouring exhausted tubes and lamps were illuminated and extinguished in unison with the action of the spark between the spheres. These, Mr. Tesla pointed out, were not electro-magnetic vibrations like the Hertz waves. He showed how, by the use of the dielectric, the spark is induced to jump between the separated spheres due to the increase in the specific inductive capacity of the medium, and he also demonstrated that the streaming discharge passed easily through thick glass plates, rubber plates, and a book. Mr. Tesla then showed the static effects in a non-striking vacuum. A tube of this nature when connected to the machine glowed brightly, and the terminals became incandescent. Mr. Tesla then remarked that if, instead of using a filament in a lamp—which necessarily limited us in the degree of incandescence which we could practically employ—we could employ solid blocks of carbon, much higher efficiency could be obtained. Based upon this reasoning, he has constructed a lamp, which he showed, containing two blocks of carbon in non-striking vacuum. When connecting these two carbons to the two terminals of the coil, or one to one terminal and the other to a body of some size, the blocks can be raised to high incandescence.

Mr. Tesla also showed a lamp with but a single rod filament in a non-striking vacuum with no outward connection. The energy is entirely transferred by condenser action through the medium of condenser coatings in the base of the lamp. He also pointed out how the brilliancy of the lamp could be varied by simply altering the relative positions of the condenser coatings. This Mr. Tesla followed by demonstration of the phenomena with an unexhausted globe, and a single filament mounted therein. The filament when connected to one terminal of the coil heats up to bright incandescence and spins around in the globe. He also demonstrated the heating by the use of Crookes's well-known apparatus consisting of mica vanes mounted above a platinum wire, which was brought to incandescence by connection with one terminal of the coil, and rotated the mica vanes.

In order to still further verify the conclusions that the electrostatic effects are alone active, Mr. Tesla placed a Geissler tube at right angles to the core and at its centre. In this position the tube did not light up. When placed at the ends, however, the tube lit up brilliantly, and gave sufficient light to read by. Mr. Tesla showed both uranium and yttria tubes.

He then showed how exhausted tubes could be made to glow in an electrostatic field. For this purpose two large sheets of zinc were connected to the terminals of the machine at a distance of about 15 feet apart. The tube when placed between these sheets glowed brilliantly, and could be moved about freely. Mr. Tesla remarked that, by merely creating such a field in a room, the mere suspension of the tubes in the room would afford the desired illumination.

Coming to the physiological effects, Mr. Tesla adjusted the conditions so that by touching one terminal with a brass sphere he raised the potential of the coil so enormously that a stream of light came out on the other terminal, and he estimated the difference of potential to be nearly 230,000 volts, and then performed the remarkable experiment of receiving the total discharge in his body, protecting his hands from burning by the brass balls held in his hands.

He then lit up lamps by holding them in contact with one terminal or near to the coil.

The lecturer then came to another class of experiments. He stated that he had used a system of conversion from high tension to low with the enormous frequencies of the condenser discharges. Mr. Tesla then showed an interesting experiment which consisted in passing the converted currents, produced in the manner just described, through a copper bar $\frac{5}{8}$ inch in diameter and bent into a loop. Ordinarily such a bar would constitute a short circuit, but Mr. Tesla succeeded in bringing lamps stretched across the parallel sides of the bar to incandescence, demonstrating that the impedance in the loop connecting the two sides was so great as to practically prevent the current from passing through it and hence acting upon the lamps in the manner described. He also pointed out the existence of nodes on the bar. His method consists in continuously charging and disruptively discharging a condenser into the working circuit, the charging of the condenser being effected by a coil operated either by alternating or direct currents. By this means any desired higher frequency may be obtained from any lower frequency.

We have given but the merest outline of the many beautiful and highly suggestive experiments made by Mr. Tesla. Notwithstanding the fact that Mr. Tesla excited the intensest interest of his audience for three hours, he was nevertheless unable, for lack of time, to bring before them many experiments, some of which, he said, were even of a more striking nature than those brought out.

THE ELECTRICAL WORKS OF THE SECTOR OF THE PLACE CLICHY.

(*Concluded from page* 615.)

Canalisation.—The canalisation adopted for the sector of the Place Clichy consists entirely of simple cables of the Siemens type. The size of the feeders depends on the distance from the works to the distributing box, or the point where the distributing wires join the feeders. Fig. 1 shows a full-sized section of one of these cables, having a surface of 655 square millimetres of copper, weighing 13 tons, and costing 38,000 francs per kilometre. These figures will enable us to form some idea of the importance of adopting the highest possible potential so as to diminish the section, the weight and the price, and of starting from the works with only two wires instead of the five, which would have to be used if accumulators and regulators were not employed.

The strand of copper forming the core of the cable is covered with a thick envelope of jute impregnated with a special insulating composition containing thick oils and bitumen. The cable, covered and insulated in this manner, is enveloped by machine-pressure in a leaden tube, on which is wound a thick matting of bitumenised hemp. On this hemp are rolled in the same direction two steel bands, not joined, but the second of which covers the interstices left by the winding of the first. The object of this is to impart to the cable a certain degree of elasticity, and at the same time to make sure that the casing of steel completely covers the cable, and is absolutely continuous, the object of this last covering being to give the cable sufficient mechanical protection. The metal is then bitumenised and covered with a last layer of asphalted serge, in order to protect it from corrosion. One of the wires forming the core of the cable has a smaller section than the others, and is insulated; this wire serves as a return wire, for showing at the works the differences of potential at the extremities of the feeders.

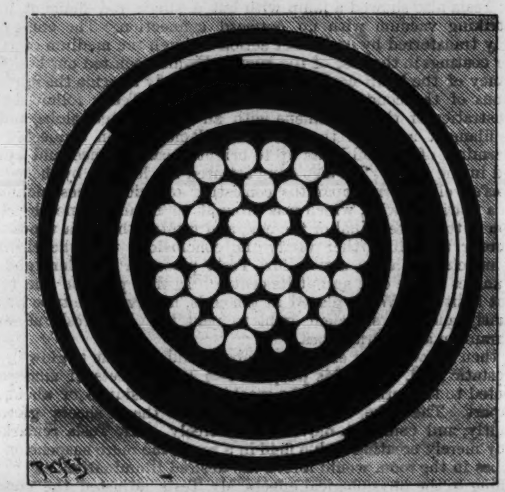

FIG. 1.—SECTION OF A FEEDER (FULL SIZE).

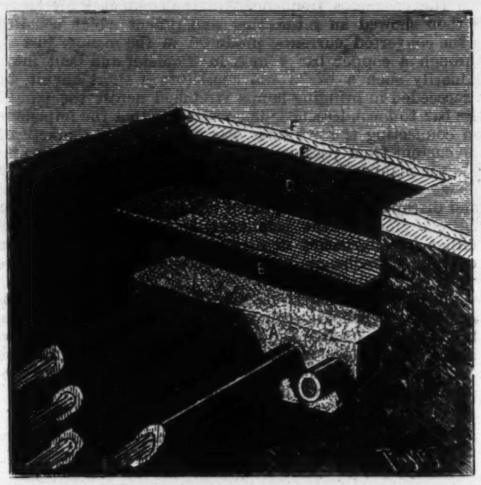

FIG. 2.—THE LAYING OF THE FIVE WIRES UNDERGROUND.

A, Sand; B, The soil of the trench; C, Metal network; D, The soil of the trench; E, Concrete; F, Bitumen.

Fig. 2 shows how these cables are laid in the ground. The operation of laying is very simple; it consists in making a trench, on which is spread a bed of sand; the cable is laid upon this, and then covered over with sand. The object of this sand is that the cable may be surrounded by a somewhat porous material, so as to facilitate drainage, and keep the cable clean in case it should be necessary to take it up.

The trench is then filled up with the soil that has been dug out, a network of tinned iron being laid down in order to give warning of the presence of the cable, in case the road should be taken up in order to make fresh canalisations, electrical or otherwise. When the trench is filled up, the layers of concrete and bitumen are superposed, and the road is restored to its former condition.

We will not here enter into the details of the boxes in which the cables join the derivation boxes, the coupling and branching boxes, the casings of leaden pipes passing through certain streets, &c. We have shown in fig. 3 the entrance into a consumer's house, in which some of these points are illustrated.

In the bottom of this trench, which is supposed to be open, are established the principal conductors which go on to the houses of the other consumers. Five branch boxes enable five derivations to be taken on the principal conductors starting from a consumer's box, whence the five wires, after having passed through the branch circuit breakers, proceed into the house. This is the most complex case, and is only resorted to for consumers possessing a large number of lamps, with a view to equalising the consumption and distributing it over the four bridges at once. For consumers of moderate importance only two bridges are connected with the house, and the distribution is effected by three wires. Lastly, small consumers having only a small number of lamps to feed are connected with one bridge only.

Meters.—Up to the present, the sector of the Place Clichy has used exclusively for the consumers quantity meters or energy meters of the Aron type, which apparatus have already been described, but the system of distribution used required a modification of the apparatus which deserves special mention. We have seen that, according to the importance of each consumer's installation, three or five wires were brought to his house, connected respectively with two or four bridges, between which were arranged the utilising apparatus (the number of which can be varied at will) set in action on each bridge. It was therefore necessary to modify the meter, so that it might register at each moment the actual total of the consumption on each bridge, notwithstanding the changes in the nature of the current on each intermediate wire when the number of lamps fed by each is altered. We will suppose for the sake of illustration, that each lamp consumes 1 ampère, and that there are in service at a given moment, as represented in fig. 4, four on the first bridge, none on the second, two on the third, and only one on the fourth. In this particular case the meter works as if a current of 7 ampères passed through it, the first wire being traversed by a positive current of 4 ampères, the second by a negative current of 4 ampères, the third by a positive current of 2 ampères, the fourth by a negative current of 1 ampère, and the fifth by a negative current of 1 ampère. In order to obtain the result desired, the quantity meter is provided theoretically with five bobbins, but practically with four only.

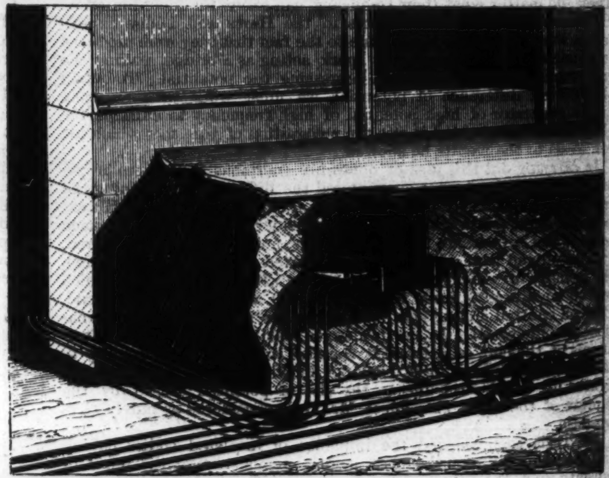

FIG. 3.—ENTRANCE INTO A HOUSE (CASE OF FOUR BRIDGES).

On the first wire the winding has a relative value equal to 2, *i.e.*, it exercises on the meter twice as much action as the winding of the second wire, which is represented as 1. This result is obtained very easily by doubling the number of spirals in the winding of wire 1, as compared to wire 2. The third wire has no winding, and communicates directly without passing through the meter.

The winding of the bobbin mounted on wire 4 is the same as that of the bobbin mounted on wire 2, and that of the bobbin mounted on wire 5 is identical with that mounted on wire 1; only these two windings are negative, *i.e.*, they only act in the same way as bobbins 1 and 2 when the currents which pass through them are of an opposite nature.

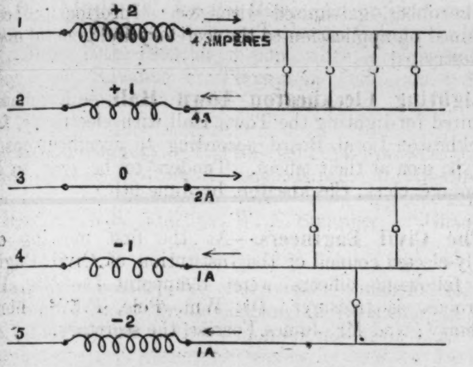

FIG. 4.—DIAGRAM OF THE MOUNTING OF THE BOBBINS ON THE METER WITH FIVE WIRES.

If, by finding the sum of the different actions with their true signs, we determine the resultant action on the meter, we find in the particular case we have taken:

For wire 1 ... $+4 \times 2 = +8$
" 2 ... $-4 \times 1 = -4$
" 3 ... $+2 \times 4 = 0$
" 4 ... $-(-1) \times 1 = +1$
" 5 ... $-(-1) \times 2 = +2$

Total .. $= +7$

The four bobbins will then act as a resultant current equal to 7, which is correct, as there are, in the case taken, seven lamps of 1 ampère in service. It is easy to ascertain that it would be the same for any other combination. The meter with multiple winding thus solves a problem, which, without this ingenious device, would necessitate the employment of four separate meters. These are the principal details of the system employed by the company of the sector of the Place Clichy, for the service of this sector. Although the majority of the utilising apparatus at present in use work at a difference of potential of 110 volts, it is evident that this can be altered at will to 220, 330, or 440 volts by a suitable grouping of these apparatus. Thus, for instance, the works supply a certain number of Khotinksy incandescence lamps of 220 volts installed at M. Augé's establishment. Electric motors of a power above 5 kilowatts can also be installed on the same difference of potential, and when tramways supplied from a central station are established in this quarter, the difference of potential of 440 volts available at the end of the feeders can be directly utilised, without its being necessary to build a special station for the purpose. These are important considerations which fully justify the adoption of the system we have described, which is a kind of compromise between the low tensions of 110 and 220 volts adopted in the other Parisian sectors, and the high tensions of 2,000 or 2,400 volts, which are reserved almost exclusively for alternating currents.

In conclusion, we take this opportunity of thanking the *Société Alsacienne de Constructions Mécaniques*, who furnished all the mechanical and electrical material, M. Lalance, the manager of the Sector Company, and M. Pirani, engineer to the *Société Alsacienne*, to whom was entrusted the arrangement of the station, for the information kindly furnished by them for this article, which is, unfortunately, far too brief and incomplete, although it greatly exceeds the space originally allotted to it.

E. HOSPITALIER.

La Nature, May 30th, 1891.

NOTES.

The Campbell Gas Engine.—We understand that the testing and working of the "Campbell" gas engine at Her Majesty's War Office has resulted in a repetition order for these engines being placed in the hands of the makers.

The Fire Protection of Electric Light Works.—The Edison and Swan Electric Light Company, recognising the danger which must always exist in a large electric light works of an outbreak of fire, have just made some valuable additions to their protective plant, in the shape of a powerful fixed steam fire engine, capable of throwing 400 gallons of water per minute, and a large manual fire engine, "The Ediswan." Both these engines are by Messrs. Merryweather and Sons.

Liverpool Corporation Electrical Laboratory.—At the meeting of the Watch Committee of the Liverpool Corporation on the 25th ult., the city engineer presented a list of candidates for the post of junior assistant to the electric inspector, Mr. Yeaman. Thirteen gentlemen had replied to the advertisement, and of these a short list of three had been compiled. The committee unanimously decided to appoint Mr. J. A. Robertson, of Peterborough, to the post. This gentleman is one of Prof. Jamieson's most successful students.

Recent Interruptions and Repairs to Submarine Cables and Land-Lines up to May 25th, 1891:—

Cables.	When interrupted.	When repaired.
Mollendo-Arica—Yquique	5th March, 1891	Still interrupted.
Céara—Pernambuco ...	14th " "	" "
Assab—Massowah ...	30th April "	4th May, 1891
Aden—Zanzibar... ...	11th May "	20th " "
Land-lines—		
Moulmein—Bangkok ...	13th " "	20th " "
Saigon—Bankok... ...	2nd " "	11th " "
" "	20th " "	21st " "

Submarine Cables of the World.—From the *Journal Télégraphique*, of Berne, we gather the following statistics concerning the submarine cables now existing. The totals are not quite complete, for since the tables were drawn up there have been considerable additions to the number of cables, principally in the list of lines owned by private companies:—

Government Cables.

Countries.	Number of cables.	Lengths. N.M.
France	55	4,068
England	195	3,600
Germany	43	1,579
Italy	38	1,027
Other countries	467	2,903
Totals	798	13,177

Companies.

Country.	Number of companies.	Number of cables.	Lengths. N.M.
England	17	194	80,674
United States ...	5	22	16,393
Sweden	1	22	6,110
France	2	9	4,389
Totals ...	25	247	107,566

The cable fleet of 36 vessels is distributed as follows:—

English Government ...	2
" companies	26
French Government... ...	2
" companies	1
Italy	1
China	1
United States and Canada ...	3
Total	36

Total tonnage = 57,000 tons.
" horse-power = 8,538 H.P.

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* The Société Générale des Téléphones has in actual construction a cable steamer of 4,000 tons.

Our Share List.—We thank "Ajax" for pointing out the mistake in the weekly share list.

Telephonic Communication in Yorkshire.—The Mutual Telephone is going to extend its operations into Yorkshire.

Cricket Match.—Woodhouse and Rawson United, Limited *v.* the Electric Construction Corporation, Limited. This match was played on Saturday last at Walthamstow, and ended in an easy victory for the former.

The Spanish-Morocco Cables.—Very little news has come to hand regarding the progress of the establishment of submarine cables between Spain and various ports on the coast of Morocco. Our readers will recollect that the contract for these cables was obtained by Messrs. Pirelli & Co., of Milan and Spezzia, and that it is some considerable time since the first section, between Almeria and Alboran, was laid. In the *Diario de Cadiz*, of the 18th May, there appeared the announcement that the section between Tangiers and Tarifa was to be laid during that month (May), and it was expected that the line would be opened to the public about the middle of June. Considering that Messrs. Pirelli were awarded the contract in November of last year, it cannot be said that this firm has conducted its operations with undue precipitancy; the whole length of cable to be laid is only about 330 miles.

The Electrolytic Assay of Copper.—In assaying copper by the electrolytic process it has been observed that sometimes the copper deposited at the beginning of the process is of a dark brown colour and whenever this is the case it usually happens that the remainder of the metal comes down in a "fluffy" condition. There is a short letter on this subject in the *Chemical News* for May 29th, in which the writer who has himself frequently experienced the same trouble states that the cause of it may be traced to using a current that is too strong for the solution. With a weaker current of electricity, and also possibly with a weaker solution of the copper, the metal would be deposited upon the cathode in a firm crust which would possess the usual shiny or rosy appearance. Whether the darkening spoken of above that is sometimes observed at the commencement of the electrolysis is due to the presence of some trace of foreign impurity set free by the current being too strong or whether the colour is due to the molecular state or physical aggregation of the deposited metal, does not transpire.

The Electric Lighting of Leeds.—The Bill to confirm the provisional order granted by the Board of Trade to the Yorkshire House-to-House Electricity Company for the electric lighting of Leeds will, as far as that order is concerned, pass unopposed through the House of Commons, no petition having been lodged in opposition within the time limited by the standing orders under this order, which contains 82 clauses. The company's area of supply is limited to "the whole of the municipal borough of Leeds," and the capital of the company is exclusively allocated to the supply of electricity within this area. The company is also placed under an obligation to lay distributing mains within a period of two years after the order has come into force along the following streets, namely:—Briggate, New Briggate, Kirkgate (from Briggate to Vicar Lane), Boar Lane, Wellington Street (from Boar Lane to the Central Railway Station), Infirmary Street, King Street, York Place, Park Square, St. Paul's Street (from King Street to Queen Street), Park Lane, East Parade, Bond Street, Commercial Street, Park Row, Cookridge Street, Albion Street, Land's Lane, Upperhead Row, Woodhouse Lane, and Headingley Lane. In the event of the company failing to lay down mains along these streets within the limited time, the Board of Trade take permissive power to revoke the whole or any portion of this order. As regards the remaining streets within the area of supply, the company is compelled at any time after the expiration of eighteen months from the commencement of the order to lay down distributing mains in any such street within six months upon being requested by requisition to do so, signed by one or more owners or occupiers of premises, or the authority having the control of the public lamps. This order will come into force immediately upon the confirmation Bill receiving the Royal Assent.

Suicide of an Electrician.—Mr. James Columbine, electrical engineer, of Soho, committed suicide at his residence at Acton on Monday last.

Railway Stores.—The Cambrian Railway Company requires supplies of copper, block zinc, antimony, block tin, India-rubber, galvanised wire, &c. Information can be obtained on application to the secretary and general manager, Oswestry.

Lighting Cleckheaton Town Hall.—Estimates are required for lighting the Town Hall with electricity, for the Cleckheaton Local Board, according to specifications which may be seen at their offices. Tenders to be sent to Mr. J. Armitage, clerk, Cleckheaton, by June 9th.

The Civil Engineers.—At the first meeting of the newly-elected council of the Institution of Civil Engineers, the following officers were re-appointed:—Mr. H. L. Antrobus, as treasurer; Dr. Wm. Pole, F.R.S., honorary secretary; and Mr. James Forrest, the secretary.

The Powerful Electric Light Again.—It is stated that Sir Edward Watkin has built a private châlet at the summit of Snowdon, and that he is making arrangements for the occasional display there of a powerful electric light, which will be visible not only over a great part of Wales and England, but as far as Ireland also.

A New Glasgow Telephone Company.—A company has just been formed in Glasgow, and will at once be registered under the Limited Liability Act, with the object of establishing a fresh telephone business in addition to that of the National Telephone Company. It is understood that French instruments will be used, and improvements introduced in the erection of wires, and that charges to subscribers will be very moderate.

Telegraph Stores.—Tenders are requested for the following articles, in such quantities as they may require, during six months ending December 31st, 1891, delivered, carriage paid, at the company's telegraph stores at York, for the North-Eastern Railway Company. 1. Telegraph apparatus. 2. Telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the secretary, at York, by noon on the 8th inst.

High Speed Electric Transport.—Mr. Pope's report on the New England Portelectric Company's system, which we republish from the *Electrical World*, will doubtless be read with much satisfaction by those who have money in it, if by no others. It would seem that the carriage of light goods at a very high speed is not of an impossible nature, and we shall look forward with considerable interest to the further development in the scheme which we trust will not share the fate which befell that of Danchell some years ago in this country. Experiments on a model track led the last named to anticipate speeds of 200 miles an hour; but in this case the model was the beginning and the end. It must in justice, however, be said that there is no similarity between the American system of employing the electric current and that advocated by Danchell.

The City and Guilds of London Institute.—The recent report of this Institute for 1891 shows that the number of students attending all four departments of the Central Institution has increased 50 per cent., and the classes at the Technical College, Finsbury, and the South London Technical Art School, are filled to their utmost limit. The department at the Central Institution and the Technical College, Finsbury, which has drawn the greatest number of students is the electrical department; at both colleges this department is overcrowded, and the Council are able to report that all those who completed their course at the end of last session have obtained employment. The success has, however, been to some extent at the expense of the chemical department. In the evening classes at Finsbury the entries during the current session up to February 20th, 1891, have been 506 in the electrical engineering department, the attendance at the day classes being 95.

Engine Indicators.—The new form of steam engine indicator which Prof. Perry brought before the notice of the Physical Society on the 22nd ult., seems destined to find considerable employment, if we may judge from the many encomiums already passed upon its merits.

The Old Students' Association.—An ordinary general meeting will be held at Finsbury Technical College on Wednesday, June 10th, 1891, at 8 p.m., when a paper will be read by Prof. Silvanus P. Thompson, D.Sc., on "Some Recent Developments in Optics."

The Royal Society.—The following papers were to be read last night :—Prof. O. J. Lodge, F.R.S. "Experiments on the Discharge of Leyden Jars." Prof. Ayrton, F.R.S., Prof. Perry, F.R.S., and Dr. W. E. Sumpner. "Quadrant Electrometers."

Rotary Currents.—We feel much indebted to Mr. A. du Bois Reymond for his courtesy in favouring us with such a valuable paper as that which appears on p. 711.

Tesla's Experiments with Alternating Currents.—We are obliged to the editors of the New York *Electrical Engineer* for an advance proof of an abstract of Mr. Tesla's remarkable lecture, which has created considerable sensation in that city. The complete lecture will not be ready for some time, but the abstract will, we hope, keep our readers *au courant* with the subject.

Ship Lighting.—The Royal steamer *Scot*, which had a most successful trial trip from the Clyde to Southampton last week, is one of the largest as well as the latest additions to the Union Company's fleet. The appointments and furnishings are on a scale which is not exceeded, if equalled, on any passenger steamer. The electric light is fitted throughout the ship, the installation, by the Messrs. Denny, consisting of 710 lights. Electric bells are also introduced, and special attention has been paid to ventilation. Two of Sir William Thomson's compasses and one of his patent sounding machines are also carried.

Last week Messrs. Napier, Shanks and Bell launched from their yard the *Lorna Doone*, built to the order of Messrs. Edwards, Robertson & Co., Cardiff, for their British Channel passenger service. The vessel has been fitted throughout with modern luxuriousness, including a complete installation of the electric light.

The Consulting Engineer Difficulty.—The Glasgow *Evening News* has been devoting lengthy articles to discussing the electric lighting of that city, and the question of Mr. Crompton's status as technical adviser to the corporation. From what we can gather, Mr. Crompton has departed both from his own advice to the lighting committee and from their instructions to him, and finally recommends a scheme in accord with neither. We have alluded on various occasions to the mischief which is involved in seeking the advice of any consulting engineer-contractor, and the *Evening News* only reiterates what we have always held in its concluding remarks, which are as follows :—"If there is one thing the public have a right to expect in connection with the obtaining of expert assistance, it is that the expert who shall advise a public body in the discharge of its duties to the public should not take advantage of his position to recommend any system or firm in which he himself has a personal or pecuniary interest. It is impossible to pretend that Mr. Crompton is not closely associated with one special development of electrical engineering—namely, the low tension system ; and although we should be the last to decry or call in question his ability as an electrical engineer, or his technical qualifications, Crompton and Co. are at least as well known as manufacturers and vendors of electrical appliances and machinery used in that system. In any right view of the duties attaching to an adviser of a public authority, this latter fact must operate to a large extent, as disqualifying him from ability to take up a strictly impartial position upon the questions at issue." It seems not at all improbable that Mr. Crompton will eventually wish that he had left Glasgow to the Scotch.

New Shetland Telegraph Cable.—H.M. telegraph steamer *Monarch* last week completed the laying of a telegraph cable between the mainland of Shetland and the island of Whalsay. The length of the cable is about six miles. Whalsay and Bressay, to which a cable has also been laid, are two of the places in which the Highlands and Islands Commission recommended that the telegraph should be extended without a local guarantee being required. The *Monarch* has left Lerwick for the south.

Researches in Electro-magnetic Induction.—The letter in our Correspondence columns signed "C. G. S." is based upon a clerical error. In Mr. Vignoles's paper, as printed in the Review last week, the paragraph on which "C. G. S." bases his remarks reads as follows :—"Table 1 gives the actual values of the B and H (the induction density in kilo-gausses and the magnetising force per centimetre of length in dynes"), &c. We sent proofs of the paper to Mr. Vignoles for corrections, and they were returned when too late to make the alteration with "C. G. S. units" substituted for "dynes." Under the circumstances it will probably not be necessary for Mr. Vignoles to make any reply.

Obituary.—It is with great regret that we learn, by a telegram received in London on the 3rd inst., that David Brooks, well known to many in England as an electrical engineer, died on Sunday last at Philadelphia, U.S.A. He commenced his connection with telegraphy as far back as 1845, since which time he has been constantly engaged in electrical work, and in furthering the use of his inventions. His patent glass insulator and his systems of oil insulation are probably known to all our readers, as he has frequently contributed to the columns of this paper articles and letters on these and allied subjects. It was his custom always to come to Europe for every important International Exhibition, and therefore he was acquainted with and made many friends among the electrical fraternities of England and the continent. His geniality and fund of humour were strong characteristics, and with them he combined a good practical knowledge of those subjects of which he made a special study, and a keen appreciation of the way to apply them commercially. We shall on the recurring occasions when he usually visited this country miss his presence greatly, and to his widow and family we tender our sincere sympathies in their bereavement.

M. Pinguet's Ear Trumpets.—In Paris these apparatus are claimed to be certain cures for deafness, noises in the ears, &c., and are based on slight continuous electric currents without shock. M. Pinguet's ear trumpet is held to be superior to all that has yet been done to cure deafness, &c., and adapts itself to any ear, especially, we imagine, to long-eared individuals, who appear to be the only persons likely to invest in such instruments. Quoting from the advertisement :—"By the electricity contained in it, it has the marvellous power of curing, in a short space of time, all affections of the ear, from whatever cause they may arise. The ear trumpet is approved by eminent physicians, and cures are attested by thousands of well-known people. The mode of employment is as follows :—Fix a trumpet in each ear for about 25 to 30 minutes a day ; it can be kept in longer without inconvenience, provided that the part affected only absorbs the electricity necessary to it ; the best time is in the morning, in bed, the moisture of the body causing the apparatus to give off more electricity. If, however, the electric current should be too feeble, the ends of each trumpet may be moistened with vinegar, pure wine, or salted water, before each application. The treatment should be continued for 15 to 20 days for slight deafness, and noises in the ears ; for more severe cases, from 25 to 30 days at the most. The cure, however, is often more rapid, even when the malady is chronic. If even one ear only be affected, the two trumpets are indispensable, in order to establish a current of electricity, and bring the metals into contact. There must be a positive pole and a negative pole, one trumpet only would produce no result." It will be seen from this that London is not the only city in which quackery flourishes. A few thousand people with long ears, buying trumpets at 30 francs the pair, would soon enable M. Pinguet, *ingenieur-électricien*, to retire from business upon a handsome competency.

NEW COMPANIES REGISTERED.

Aurora Electric Lighting and Distribution Company, Limited.—Capital, £25,000 in £1 shares. Objects; to establish, carry on, and develop in the United Kingdom and abroad the business of an electric light company in all its branches; to construct, lay down, establish, fix and carry out all necessary machinery, engines, cables, wires, lines, accumulators, lamps; to generate, accumulate, distribute, and supply electricity; and to carry on the business of electricians, mechanical engineers, suppliers of electricity, &c. Signatories: Rev. H. J. Tilley, Romford, Essex (5 shares); W. F. Latorre, Romford (5 shares); E. F. le Sonef, 54, New Broad Street, E.C. (9 shares); F. J. Latorre, Albert Villa, Romford (5 shares); D. M. Gill, 118, Cannon Street, E.C. (5 shares); W. Graham, 13, Crutched Friars, E.C. (1 share); H. J. le Sonef, Woodford Green, Essex (5 shares). The number of directors is not to be less than three, nor more than seven, the first to be appointed by the subscribers. Qualification, £25; remuneration, £100 per annum divided between them. Registered on the 29th ult. by F. Ridley, 52, Leadenhall Street, E.C. Office: 54, New Broad Street, E.C.

Bournemouth and District Electric Supply Company, Limited.—Capital, £50,000 in £5 shares. Objects: to acquire the business of supplying electricity for light and power hitherto carried on at Bournemouth by the Brush Electrical Engineering Company, Limited, and for that purpose to enter into an agreement, the draft of which is already prepared, and for the purposes of identification has been subscribed to by one of the signatories hereof with the Brush Electrical Engineering Company, Limited; and to carry on the business of electric engineers, electricians, engineers, and contractors, manufacturers of electrical apparatus, chemical engineers, &c. Signatories (with one share each): J. A. Hosker, Boscombe; L. E. Scarth, Keverstone, Bournemouth; A. H. Sanderson, Maywood, Bournemouth; G. J. Piercey, Sunny Holt, Bournemouth; H. U. Wollaston, 9, Pine Tree Glen, Bournemouth: A. E. F. Francis, Observer Chambers, Bournemouth; D. W. Preston, Penryn, Bournemouth. The number of directors is not to be less than three nor more than seven, the first being:—J. Fair, W. Fisher, D. M. Fox, J. A. Hosker, G. J. Piercey, A. H. Sanderson, and L. Scarth. Qualification, 20 shares. The remuneration of the directors is to be determined by the Company at the general meeting, provided that for the first three years from the incorporation of the company they shall not receive more than £350 per annum among them, unless a dividend of 5 per cent. per annum is paid. Registered on the 1st inst. by Renshaws, 2, Suffolk Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Simplex Electrical Syndicate, Limited. — At an extraordinary general meeting of this company, held on the 22nd April, 1891, at 4, Hercules Passage, Threadneedle Street, E.C., the following resolution was passed, and at a subsequent meeting, held on the 7th May, 1891, the resolution was confirmed: "That the Simplex Electrical Syndicate, Limited, be and is hereby wound up voluntarily in pursuance of the Companies' Act, 1862." The annual return for 1890—91, made up to the 6th ult., was filed on the 9th ult. The nominal capital is £6,000 in £50 shares. 120 shares have been taken up, upon 60 of which the full amount has been called and paid, and upon the remainder the full amount has been considered as paid. Office, 109, Farringdon Road, E.C.

CITY NOTES.

Notting Hill Electric Lighting Company, Limited.

THE annual general meeting was held on Saturday at Bulmer Place, Notting Hill. Prof. William Crookes, F.R.S., who presided, said they had that day inaugurated a system of lighting which, he trusted, would go on continuously, night and day, for the Parliamentary term of 42 years. They had purchased the freehold of Victoria Gardens, and the lease of seven small houses in Bulmer Place, adjoining the works, to avoid waste of time in the erection of the works, as considerable delay was occurring in consequence of injunctions obtained by the owners of the Bulmer Place property against the company proceeding with its operations. The mains had been laid in the principal part of the compulsory area, and comprised about three miles of culverts, and five miles of cables. Working as they did, on the three-wire system, they had thus laid about nine miles of copper strip, or a total of 14 miles of conductor, containing altogether 67 tons of copper. It was proposed to extend at once to Westbourne Grove. An accumulator station was being arranged for Phillimore Mews, which would give them great facilities for supplying houses in their southern district. They were in treaty for a new site for the second central station near Addison Road, which the directors had every reason to hope would be self-supporting from almost its commencement. The light had been supplied to a few houses experimentally for some weeks, during which time it had been subjected to careful tests as to steadiness and uniformity, and no fault had been detected, while not a single flaw or leakage had been found in their system of mains. For the present they expected to run entirely from batteries which would be charged a few hours a day, increasing as the load increased. He concluded by moving the adoption of the report and accounts.

Mr. S. WATERS seconded the motion, which was carried unanimously.

At a meeting of the general public of the district, held afterwards, Prof. Crookes gave a detailed explanation of the company's works and its principle of lighting, Mrs. Crookes performing the ceremony of formally turning on the electric current.

Birmingham Electric Supply Company.

THE first annual meeting of this company was held on Tuesday last week at the offices, Dale End, Birmingham, Mr. Henry Buckley presiding.

The report of the directors was as follows:—"The directors are glad to be able to announce that the works of the supply station and the mains through a considerable portion of your area are complete and in working order. The works were formally opened by the Mayor (Mr. Alderman Clayton) on the 22nd of April, 1891. The demand for the light has been most satisfactory, and the works start on a system of 2,580 16-C.P. lamps. These lights are distributed amongst various offices and shops representing some of the most important professional and trade interests in the city, one of the first customers being the Corporation of Birmingham, with whom arrangements are made for the lighting of the Victoria Courts. In the purchase of the land and the laying out of the works and mains it has been necessary to provide for not only the present but for the future demand for the light—*i.e.*, the available land is sufficient for a station estimated to provide 25,000 16-C.P. lamps, and a chimney stack has been built large enough for this. The engine house and boiler shed will be sufficient for half this number, and for the immediate supply engines and boilers have been fixed for 5,000 lamps. Mains have now been laid through the most important streets within the company's area, and current may be obtained along 7,000 yards of street frontages The company have been fortunate in securing a substantial tenant for a portion of the offices which will not at present be required."

In moving the adoption of the report,

The CHAIRMAN said he had not a great deal to add to what he said at the recent opening of the company's works. The orders were coming in very satisfactorily. Up to the present they had received orders for 2,639 lamps, but when they saw that such orders were spread over only 42 customers, it showed the shareholders what a good opening there was for the extension of their trade in the city. Bearing this in mind, the directors had resolved to issue the balance of the shares in the first instance amongst the shareholders. This would enable them to cope with additions to plant that the extension of business will demand, and he was glad to inform them that, considering the broken holiday week, the shares had been well taken up. He thought he was justified in the statement that with the present year they would be able to pay the entire working expenses, and if that turned out as he expected, at the end of 1892 there was reasonable expectation that they would pay a dividend. But that must depend upon the earning power of the company in Birmingham and the number of lamps applied for, and judging by the experience of other electric companies, he believed they would be making a profit from 1892.

The report was adopted.

The retiring directors (Mr. G. S. Albright and Mr. Buckley) were re-elected, and the auditors (Messrs. Sharp, Parsons and Co.) were reappointed.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 5s. per share, free of income tax, for the quarter ended March 31st last, and payable on the 24th inst.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended May 29th, 1891, amounted to £4,794.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of May, were £3,600, as compared with £3,409 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of May, 1891, are £2,168, as against £2,244 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of May were £53,829, as against £53,373 for the same period of 1890, or an increase of £456.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 29th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (May 28.)	Closing Quotation. (June 4).	Business done during week ending June 4, 1891.	
					Highest.	Lowest.
250,000l	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,881,380l	Anglo-American Telegraph, Limited	Stock	46½— 47½	46½— 47½	47	...
2,809,310l	Do. do. 6 p. c. Preferred	Stock	84½— 85½	84 — 85	85	84½
1,809,310l	Do. do. Deferred	Stock	11½— 12	11¼— 11¾	11¾	11½
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	12$\frac{1}{16}$	11½
84,500l	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000l	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2⅛— 2⅜	2¼— 2½	2$\frac{7}{16}$	2$\frac{5}{16}$
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1⅝— 1⅞	1⅝— 1⅞	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	5 — 6	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	106 —108	106 —108	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	½— ⅝	½— ⅝	½	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	17⅛	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,800	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10½	10¼— 10½	10½	10$\frac{5}{16}$
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14⅜— 14⅝	14⅝	14⅜
70,000	Do. 6 p. c. Preference	10	15¼— 15¾	15 — 15½	15½	...
200,000l	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000l	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾— 15	14¾— 15	15	14⅝
91,800l	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	103½	...
325,200l	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000l	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	105½	...
135,000l	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	103½	103½
180,400l	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	104 —107	105	...
201,600l	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5 — 6	5 — 6	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅝— 2¼	1¾— 2¼	2	1⅞
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2½— 3	2½— 3	3⅛	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1½	1 — 1½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9¼— 9½	9⅜— 9⅝	9½	9$\frac{1}{16}$
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	15 — 15¼	15$\frac{3}{16}$	15
150,000	Great Northern Tel. Company of Copenhagen	10	18¼— 18¾	18½— 18¾	18¾	18¾
230,000l	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334l	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10 — 11	10 — 11	...	...
5,334l	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19$\frac{1}{16}$	18⅞
200,000l	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000l	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9 — 9½	8¾— 9¼	9$\frac{3}{16}$	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞	4⅝— 4⅞	4¾	4$\frac{9}{16}$
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 12¾	13	12½
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	12 — 12½	11¾— 12¼	...	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	103 —105	104 —106	105¼	104¼
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
300,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ¼	⅛— ¼	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3 — 3½	3 — 3½	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	114 —118	118	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4¼— 4⅝	4½— 5	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	46 — 48	47	46½
150,000l	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128l	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200l	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900l	Do. do. do. 5 p. c. Debentures	100	96 — 99	96 — 99	...	...
80,000	West Coast of America Telegraph, Limited	10	3½— 4½xd	3½— 4½	...	...
150,000l	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 — 105	100 — 105	101¾	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11$\frac{5}{16}$	11¼
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6$\frac{13}{16}$	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4¾— 5¼	4½— 5	5	4⅝
200,000l	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	104 —107	...	...
250,000l	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	105	104½
88,321	West India and Panama Telegraph, Limited	10	2⅞— 3⅛xd	3 — 3¼ xd	3½	3⅜
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12½xd	11½— 12 xd	4⅞	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9½— 10½xd	9½— 10½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
176,100l	Do. do. 6 p. c. Sterling Bonds	100	100 —104	100 —104	...	..
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	5	4¾—5¼	4½— 5	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 30—34.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4¾—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 2—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—St. James's and Pall Mall Electric Light £5, 5⅞—6⅛.—St. James's and Pall Mall, 7 per cent. pref., ⅝ to ⅞ prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2¼—2⅝.—Preference, fully paid 3⅞—4⅜.—Debentures 90—95.—Woods Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—4 per cent. (4th June, 1891).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers, May 21st, 1891.

CONTINUATION OF DISCUSSION ON SOME EFFECTS OF ALTERNATING CURRENT FLOW IN CIRCUITS HAVING CAPACITY AND SELF-INDUCTION.

By Dr. J. A. FLEMING, Member.

(*Authorised Abstract.*)

Major **CARDEW** remarked that the condenser on which the experiments mentioned in paragraph 12 of Dr. Fleming's paper were made, had been constructed from imperfect plates, and since then a good condenser, kindly lent by Dr. Muirhead, had been carefully tested for capacity by the alternate current method. The capacity so found was in this case also greater than the capacity given by the makers. The discrepancy, he thought, might be due to the fact that Dr. Muirhead determines his capacities by rapid charges and discharges, which, in consequence of absorption, would give a result too low, whereas in the alternate current method the absorption would have the effect of increasing the apparent capacity. Experiments had also been made by the voltmeter method, described by Prof. Ayrton and Dr. Sumpner, and Mr. Swinburne, on the power spent in a one microfarad condenser when subjected to alternating pressures of 650 volts. The power found was 5 watts, and after a long continued run the condenser was not much heated.

Dr. **SUMPNER** pointed out that many of the formulæ given by Dr. Fleming could not be used practically without considerable reservation as to the values to be substituted for R and L in the expressions. Those obtained by bridge tests and ballistic methods would (if used) lead to conclusions which were entirely disproved by experiment. Years ago, Maxwell showed that the mutual induction of two coils produced a result similar to that brought about by increasing the resistance of the primary and diminishing its self-induction. Since secondary circuits exist in all electrical apparatus in the shape of iron, copper, &c., not infinitely laminated, the changes in the so-called "constants" of the primary coil may be very important. The ordinary formula for the angle of lag between the E.M.F. and current in a coil being $\cos\theta = \frac{\text{resistance}}{\text{impedance}} = R\,\frac{A}{V}$ where A is the current and V the volts, then since the watts given to the primary of a transformer with open secondary is watts $= V\,A\cos\theta$, and this by substitution becomes $V\,A\,.\,R\,\frac{A}{V} = A^2\,R$; the power spent in the transformer would come out to be that wasted in heating the primary coil, if the value of R taken be that obtained by bridge tests. This, of course, was a totally wrong result, because the effect of hysteresis and Foucault currents was to virtually increase the resistance of the primary circuit. The results of bridge tests could not therefore be used in the customary manner. To get correct results it was also necessary to determine L by alternate current methods, but as nearly all these methods involved the assumption that impedance $= \sqrt{R^2 + p^2\,L^2}$, if the wrong resistance be taken, the resulting value of L would be inaccurate. Considering the Ferranti 150 H.P. transformer, and assuming that its existing current was 5 ampères, he pointed out that according to ordinary methods of reckoning, $L\,p$ would be about 2,000. This, although it only gave a time constant of about $\frac{1}{3}$rd of a second, whilst in the coil chosen by Dr. Fleming $\frac{L}{R} = 20$ seconds, was nevertheless about 100 times greater than that required to produce a lag of 80°. If, however, the value of R be taken as determined by the power spent on open secondary circuit, the ratio of inductance to resistance would only be about $\frac{1}{1000}$th of that possessed by Dr. Fleming's coil. The author, he said, had made no reference to Mr. Swinburne's views on the Ferranti effect, nor to the results published in a paper read by Prof. Ayrton and himself, before the Physical Society. The experiments given in Table I (section 17) did not show whether any of the rise occurred in the dynamo as well as in the transformer. The same theory accounted for rises in both parts, but as Mr. Swinburne had pointed out, the primary circuit of a transformer could not act like a coil with self-induction, unless there was some magnetic leakage. In the experiments made at the Central Institution it was found that under certain conditions about half the rise was due to the self-induction of the transformer, and the other half to the dynamo; the proportions differed, however, with the ratio of transformation.

Mr. **BLAKESLEY** said that for some time he had considered the measurement of self-induction by alternate current methods to be a dangerous operation, particularly when there was iron in the field, for in that case a coefficient was hardly conceivable. In 1886 he tested the coefficients of a Gaulard and Gibbs transformer, which, because the primary and secondary were similar and similarly situated, ought to have had a ratio of 1 : 1, really gave a ratio of 3 : 2. Speaking of the rise of pressure produced by capacity, he pointed out that he published an account of such a rise long before the Deptford station was commenced, and he was not at all surprised when he heard that such a rise occurred there.

Mr. A. **SIEMENS**, referring to the curve given in fig. 6, said that more recent experiments, using a different type of transformer, showed that the ratio of transformation was independent of the capacity.

Prof. **AYRTON** enquired what was the difference in the two kinds of transformer used, and

Mr. **SIEMENS** replied that one was an open-circuit, and the other a closed-circuit transformer.

Mr. **SWINBURNE** directed attention to the practical points to be attended to in coupling alternators in parallel on mains having capacity. Another important point he had recently observed was that by employing a motor in conjunction with an alternator, the effect of capacity could be neutralised, for weakening the fields of the motor caused it to act like a self-induction. By strengthening the fields of a motor, it could be made to act like a capacity. Hence, even in transmitting power over long distances by alternate currents, an attendant at the receiving end could maintain the pressure at that end constant independent of the load by simply varying the strength of the fields of a motor working on the circuit.

Dr. **FLEMING**, in his reply, thanked Dr. Sumpner for calling attention to the parts he had omitted from the paper, and said that some practical method of getting the inductance of a transformer at any load was greatly needed. He, Dr. Fleming, had hitherto failed to get a clear idea as to what Mr. Swinburne's views really were, but he thought that both the orthodox theory and the armature reaction view would be found wanting in some respects. A significant fact, however, was that with large machines of small inductance, no rise was observed; whereas, when small machines of comparatively large inductance were used, the rise was great. In laying out future stations it would be quite safe to use concentric cables where alternators of small inductance could be coupled direct on the mains. Whilst agreeing with Professor Ayrton's remarks about the faulty wording in paragraph 6, and on the simplification of formulæ suggested, he thought that the criticism concerning the coil with a time constant of 20 seconds which he (Dr. Fleming) had chosen, was unnecessary, since Mr. Preece had given an instance of a coil which required two minutes for the current to reach its maximum, and Mr. Bate had called his attention to the fact that the field magnets of an Edison "Jumbo" machine required nine seconds for the current to attain its maximum. The construction of a coil such as he had imagined was thus only a question of cash, and of space, and was not an impossibility. Speaking of the formulæ given in his paper, he pointed out that good condensers could be looked upon as having negative inductance = to $\frac{1}{C\,p^2}$ and impedance $\frac{1}{C\,p}$. For leaky condensers the inductance was given by $-\frac{C}{k^2 + C^2\,p^2}$, where k is the conductance of the condenser. The resistance of such a condenser to alternating currents was represented by $\frac{k}{k^2 + C^2\,p^2}$, and its impedance by $\frac{1}{(k^2 + C^2 p^2)^{\frac{1}{2}}}$. The denominator of the latter expression had, he said, been called the *admittance* of the condenser by Mr. Heaviside, and just as *impedance* had now come into general use, so *admittance* would be found necessary when high frequencies become more common. Referring to Major Cardew's experiments on condensers, he thought that the observed effects might be due to leakage, for a leak would cause the capacity to appear greater when tested by alternating currents, and less when direct currents were employed. He could not agree with Mr. Evershed about the quantity $L\,p$ being of the nature electromotive force, for although it was not of the nature of resistance in the sense of being dissipative, yet its dimensions were those of resistance, and only those of E.M.F. when multiplied by current. On the subject of throwing machines in parallel he pointed out that the procedure depended entirely on the nature of the machines and of the circuit, for the operations necessary to put the large Deptford machines in parallel on the mains were the reverse of those required when the small machines were used. There was, he thought, still considerable room for investigation to separate the rise due to transformers from that due to armature reactions. One great difficulty was experienced in getting the resistances and inductances of the machines or transformers. Dr. Sumpner, he said, had greatly overestimated the magnetising current of the Deptford transformers, for, instead of being 5 ampères, it was, he thought, only 4 ampères.

CONTINUATION OF DISCUSSION OF "SOME POINTS CONNECTED WITH MAINS FOR ELECTRIC LIGHTING," by W. H. PREECE, F.R.S., Past President; and on "THE MOST ECONOMICAL MODE OF FEEDING A LOW PRESSURE NETWORK," by R. E. CROMPTON, Vice-President.

Mr. **ADDENBROOKE** said that the object of Mr. Preece's paper was to point out the economy of the high pressure principle, whilst that of Mr. Crompton's was to impugn that principle. On examining the question as to the cost of high pressure mains, he found that to give a 10 per cent. loss in 2,400 yards of feeder supplying 100 kilowatts at 2,000 volts would require a 7/14 cable, and this of best Silvertown make would cost about £165 per mile. This would give the cost of cable about £400 instead of £1,300 as stated in Table I. The cost of the culvert or pipe was taken the same for both the high and the low pressure feeder. This he thought was unfair to the high pressure system, and the cost of the transformers and apparatus was also too high. Altogether, the cost of the high pressure feeder ought to be put at about half that of the low pressure one under the conditions there stated. These conditions were, however, not practical ones, for no A.T. engineer would allow a drop of 10 per cent. in so short a feeder; $2\frac{1}{2}$ per cent. would be much more reasonable. Taking this drop, the cost of the cables would come to about £1,300, but the $7\frac{1}{2}$ per cent. saving would mean an increased revenue of about £160 per annum.

Mr. **JACKSON** described the method of laying underground concentric mains as carried out by the Newcastle-upon-Tyne Electric Supply Company, and exhibited samples of the work. The system, he said, was a draw in and draw out one, using cast iron pipes and concentric cables for 2,000 volts pressure. The joints were made in junction boxes by bolting copper rings cast to thimbles, in which the ends of the cables were sweated, to the tops of porcelain insulators.

The same points served also as connections for service lines. The advantages claimed were: simplicity and small cost; a six mile circuit to feed 12,000 lamps, with a variation of pressure never exceeding 6 per cent., having been laid at about £1,100 per mile. At the suggestion of the President, Mr. Jackson promised to communicate further details in writing for publication in the journal.

Mr. **KAPP** said the case which Mr. Addenbrooke had made out for the A.T. system was not strong enough, for Mr. Crompton's calculations were vitiated by not taking the extra cost of plant into account. With a low pressure feeder of 90 per cent. average efficiency, about 30 per cent. more boiler, engine and dynamo power would be required, as well as 30 per cent. more wages, &c., than for a high pressure system. Mr. Crompton would thus have to lay down 30 per cent. more plant, and pay 30 per cent. more wages and interest for the privilege of using a low pressure feeder.

Major General **WEBBER** said Mr. Crompton wished them to believe that the A.T. people had now found that it would be necessary to use a low pressure network such as used in direct current distribution. This he said was by no means new, for Mr. Ferranti, as long ago as 1885, described a system like the one now mentioned by Mr. Crompton. Referring to table II., he noticed that its author there admitted that 25 per cent. of the 2,400 yards of feeder would have to be laid in tubes. In practice, however, it was found that culverts could only be used for about one-quarter of the total distance, and making this change would increase the cost of the low-pressure feeder by about £2,000; the interest would also be considerably augmented. Speaking of the 1 per cent. depreciation allowed on culverts and copper, as against 8 per cent. on cables, he said there was no admitted proof that the upkeep of one would be only one-eighth of the other. This point he (Major-Gen. Webber) had referred to in his paper read last winter, but he was now sure that the figures 1 per cent. and 8 per cent. could not be admitted. Sir W. Thomson enquired what ratio the energy sold, had to that generated, in the various systems of distribution. In his opinion the comparison would be favourable to the low-pressure system wherever it was practicable. In dealing with large conductors, both Mr. Preece and Mr. Crompton seemed to have ignored the fact that the conductivity was less for alternating currents than for direct ones. Conductors of 2 centimetres diameter offered 8 per cent. more resistance when the frequency was 80, whilst for 3 cms. diameter the increase was 31 per cent. Mr. Preece's square inch section conductor would offer 25 per cent. more resistance to an alternating current of 80 periods per second, and at 100 periods the increase would be 30 per cent. As this was a matter of considerable importance in low pressure networks he would suggest that all cables for currents greater than 200 ampères be made with jute instead of copper in the centre. On the whole, he thought it injudicious to rush to alternate currents for distribution purposes, and he himself rather inclined to continuous current distribution by feeders, as described by Edison. He was quite aware of the processes which had led to the A.T. system being usually preferred, and of the great advantages which in some cases could be realised by its use, but he believed that in future the direct system would predominate. The general idea in putting the generating station at a distance, was to obtain cheaper coal, but he doubted whether more than 6d. per ton would be saved in this way. The possible use of condensation was another item, but, so far as he was aware, triple expansion condensing engines had not come into use for lighting purposes. Rent of land was, however, an important consideration, as well as the necessity of diminishing vibration. Both these told in favour of the distant station, and, in his opinion, no other consideration ought to prevent engineers from putting their stations as near as possible to the consumers.

Mr. A. **SIEMENS** thought the principal object to be aimed at in designing stations was *simplicity*, and the design for a particular district must be guided largely by local circumstances. In his opinion the discussions on both Mr. Crompton's papers had converged too much on high and low pressure. Speaking of cables he said, that in addition to the theoretical conditions referred to by Sir W. Thomson, practical and financial points had also to be kept in view. In making concentric cables for the London Electric Supply Corporation, they had found that putting in a jute core increased the diameter of the cable, and added considerably to the cost. It was cheaper for them to put in extra copper to make up the conductivity. Referring to Mr. Crompton's estimate for the upkeep of mains, he concurred in Major-General Webber's protest against the 8 per cent. for insulated cables. As a matter of fact neither the cables put down in Berlin in 1881, or those in use at Bradford had cost a farthing for upkeep since they were laid. In his opinion the upkeep of cables ought not to be put at a higher figure than that allowed for culverts.

Mr. **SWINBURNE** said the "skin effect" could be minimised even in large conductors by making them, say, in 6 smaller cables stranded round an inactive centre.

Sir W. **THOMSON** pointed out that if each wire of such a cable was as much outside as any other wire, the full conductance would be obtained, but this condition was not fulfilled in cables as ordinarily constructed; and in conductors two or three centimetres in diameter the conductivity for alternating currents is seriously diminished. With reference to the upkeep of cables, he thought that if properly constructed and laid the upkeep should be practically nil.

Mr. A. E. **MAVOR** said that by soaking the separate wires in an insulating medium before stranding, considerable resistance could be got between the strands; a light serving of cotton did not seriously increase the diameter of the cable. In this way he thought Mr. Preece's square inch section could be obtained without much diminution in conductivity for alternating currents. He characterised Mr. Crompton's estimate of £1,300 for 2,400 yards of concentric cable as absurd, and he assured Mr. Preece that great attention was being given to the construction of mains. He was also of opinion that rubber would be superseded by cheaper dielectrics. On the subject of feeding a network, he had no doubt but that high pressure cables would be much cheaper than low pressure ones.

Mr. **PREECE**, in reply to Sir W. Thomson, said that in one alternate current system with which he was acquainted, the coal burnt per unit sold was 17 lbs., whilst per unit generated it was 8 lbs. In Rome, however, these numbers were 10 lbs. and 8½ lbs. respectively. This satisfactory result he attributed to the system of "banking" the transformers. Of direct current systems, he said that Mr. Crompton's statements were not corroborated by the company's returns, for whilst he (Mr. Crompton) gave 7 to 8 lbs. as the consumption per unit generated, and 8 to 9 lbs. per unit sold, a director informed him (Mr. Preece) that they did not get paid for two thirds of what they generated. He hoped that before long it would be usual to get an indicated horse-power-hour for 2 to 2½ lbs. of coal, and that 6 or 7 lbs. per unit sold would suffice. Referring to the one square inch section of copper mentioned in his paper, he said this was taken merely as an illustration. In practice, none of the mains need ever exceed a quarter of a square inch in area, and as shown in his paper before the British Association, the reduced conductance of such sizes for ordinary frequencies was not important. Sir W. Thomson, he remarked, had said a great deal in favour of low pressure systems with numerous stations, but in so doing he had apparently overlooked the fact that working expenses were greatly increased by this duplication of stations. In designing the Bristol scheme two stations were found to be much more expensive than one, and it was for this reason and on account of its greater "simplicity" that the alternate current system with one station had been chosen. The three-wire system, he said, was not financially possible at distances greater than half-a-mile, whilst for five wires the limiting distance was about a mile.

Mr. Crompton, not being present, did not reply.

Physical Society, May 22nd, 1891.

Prof. W. E. **AYRTON**, F.R.S., President, in the chair.

Mr. F. H. Neville was elected a member of the Society.

Prof. **PERRY**, F.R.S., showed a new form of steam engine indicator. A galvanometer mirror is fixed to a steel disc forming one side of a chamber filled with the steam under test. The pressure of the steam bulges out the disc and causes the mirror to deflect a ray of light thrown on it in the ordinary way. A rotation at right angles to the former is imparted by the movement of the piston rod. The ray of light traces out the diagram on a screen suitably placed, and the complete figure is continuously visible owing to the persistence of impressions. This indicator possesses advantages over other forms, in being free from errors due to friction, or oscillations of the springs and the alternation of their elasticity due to temperature changes. The errors of ordinary indicators are considerable at high speeds owing to the ripples introduced into the indicator diagram. If the natural period of the spring is $\frac{1}{20}$th of the time of a revolution, the diagram is fairly free from ripples, but if it is as much as $\frac{1}{10}$th, no amount of friction in the indicator will prevent ripples forming. In the new indicator the natural period of the disc can be made very short. The steel discs are easily movable and can be proportioned to suit different pressures and speeds. For experimental and teaching purposes it is advantageous to see at once the alterations in the diagram caused by changes of load, pressure, &c. Several diagrams were exhibited to the meeting.

In reply to Mr. **CARUS WILSON**, Prof. **PERRY** stated that the deflection was proportional to the pressure in the cylinder within the limits any particular disc was intended for.

Mr. **ADDENBROOKE** thought the instrument an important improvement on its predecessors, and considered it would prove of great service to electrical engineers.

Mr. **SWINBURNE** said a peculiar merit of the indicator was that it could be permanently attached to an engine like an ordinary pressure gauge. He suggested the use of a small telescope instead of the ray method.

The **PRESIDENT** thought that the instrument could be modified so as to be useful for analysing the shape of the curves representing alternating currents.

ON BLAKESLEY'S METHOD OF MEASURING POWER IN TRANSFORMERS.

By Prof. **PERRY**, F.R.S.

This paper refers to the supposed error in Mr. Blakesley's formula, due to the fact that transformers show magnetic leakage. The proofs of the formula hitherto given have been obtained by treating the equations in the manner first adopted by Dr. Hopkinson. On this system the reactions of the primary and secondary currents are represented by the equations

$$V = R_1 C_1 + P \frac{dN}{dt} \qquad O = R_2 C_2 + S \frac{dN}{dt}$$

where P and N are respectively the turns on the primary and secondary coils, and N is the magnetic flux between the coils. Here it is assumed that there is no magnetic leakage, and the author thinks that on this account the method is inferior to the original method of Maxwell, in which the induced electromotive forces are expressed in terms of coefficients of self and mutual induction. On the assumption that there are no eddy currents, Maxwell's equations are

$$V = R_1 C_1 + L_1 \dot{C}_1 + M \dot{C}_2; \qquad O = R_2 C_2 + M \dot{C}_1 + C_2 \dot{C}_2$$

in which, although L_1, M and L_2 may not be constant, it may be assumed that they are respectively proportional to P^2, $P\,S$ and S^2, if there is no magnetic leakage, and if the amount of magnetic leakage bears a constant proportion to the whole flux, the three quantities may still be assumed proportional to each other, although M^2 is less than $L_1 L_2$. From these equations we obtain

$$V C = R_1 C_1^2 - R_2 \frac{M}{L_2} C_1 C_2 + \frac{L_1 L_2 - M^2}{L_2} C_1 \dot{C}_1$$

Hopkinson puts down the last term as zero, but owing to the very rapid rate at which c_1 changes, the last term is very important, even though M may be but a small percentage less than $\sqrt{L_1 L_2}$. On integrating this equation, the first two terms on the right hand side yield Blakesley's formula, and the last term vanishes in the integral, because however great the magnetic leakage may be

$$\int c_1 \dot{c}_1 \, dt = 0$$

when taken over a period because the functions are periodic. Mr. Blakesley's formula thus appears to hold whatever the magnetic leakage. The paper contains several tables of calculation showing the effect of magnetic leakage on the value of the terms in the equation.

Mr. BLAKESLEY said he doubted the correctness of the assumption that the value of M was the same in the two equations, and thought that the result arrived at must be incorrect.

Dr. SUMPNER did not doubt that if the coefficients could be considered constant the formula was true whatever the leakage, but he did not consider that the action of transformers justified such an assumption. If the formula were true, it would also hold if there were eddy currents, as these would merely produce the effect of additional secondary coils. He had analysed Blakesley's method by using a modification of the Hopkinson equations, and had shown that the power as estimated by Blakesley's formula had to be lessened by the fraction represented by the expression

$$X = \frac{\int x \dot{A}_p \int A_s \, dt \, dt}{\epsilon + \int A_p A_s \, dt}$$

where A_p and A_s are the instantaneous values of the primary and secondary currents, and x is such that $N_p = N_s (1 + x)$ where N_p and N_s are the fluxes of magnetism through the primary and secondary coils at the same instant, ϵ is a negligibly small quantity compared with the rest of the denominator. In obtaining this factor no assumptions whatever had been made, and it was easy to see that if A_p and A_s could be assumed sine functions, and x a constant, the value of the factor X became x simply. In only one case did X reduce to zero, and that was when x was a sine function of the same period as A_p and A_s. He believed that in actual transformers x was approximately constant.

Mr. SWINBURNE pointed out that the split dynamometer was merely a wattmeter, and stated that he had transformers which, owing to magnetic leakage, would indicate an efficiency of over 100 per cent. if tested by Blakesley's method. If this method gives an efficiency of 96 per cent., and leakage causes a drop of 2 per cent in E.M.F., the real efficiency is only about 94 per cent. He thought that the assumption that the currents followed a sine law was equivalent to supposing that there was no loss in hysteresis.

The PRESIDENT said that no one would be more glad than himself to find that Mr. Blakesley's method was accurate, but he could not agree with Prof. Perry that Dr. Hopkinson was wrong in abandoning the academical method of Maxwell.

Prof. PERRY replied to the various points raised in the discussion.

A paper on "Currents and Potential Difference Analogies in the Methods of Measuring Power," by Prof. W. E. Ayrton and Dr. Sumpner was postponed.

NEW PATENTS—1891.

8,048. "Improvements in dynamo-electric generators." R. KENNEDY. Dated May 11th.

8,053. "An electro-magnetic stop motion, applicable to machinery used in the spinning, twisting, or the doubling winding of silk, cotton, wool, worsted, flax, jute, hemp, or other fibrous materials." C. W. R. HAWKESWORTH. Dated May 11th.

8,102. "Improvements in arrangements by which a passing locomotive or train will cause a current of electricity to be transmitted for actuating signals, and for other purposes." J. A. F. ASPINALL and H. A. HOY. Dated May 12th.

8,126. "Improvements in compound dynamo-electric generators." G. J. PHILPOTT. Dated May 12th.

8,141. "Improvements in or relating to treating or manufacturing certain forms of insulated electric conductors." W. P. THOMPSON. (Communicated by J. B. Williams, United States.) Dated May 12th.

8,153. "Improved means for carrying electro-motors on electrically propelled cars or vehicles." SIEMENS BROTHERS AND CO., LIMITED. (Communicated by Siemens and Halske, Germany.) Dated May 12th.

8,163. "Improvements in electric railways." M. W. DEWEY. Dated May 12th. (*Complete.*)

8,198. "An improved electricity meter." R. H. HOUSMAN, C. W. DIXON and S. H. HOLDEN. Dated May 13th.

8,218. "Improvements in dry batteries." A. R. SENNETT and F. W. CANNON. Dated May 13th.

8,225. "Improvements in arrangements or apparatus for starting, working, and stopping or controlling signals by electricity, also applicable for other purposes." J. A. F. ASPINALL and H. A. HOY. Dated May 13th.

8,227. "Improvements in electrodes for electric accumulators." W. P. THOMPSON. (Communicated by H. O. Tudor, Germany.) Dated May 13th.

8,256. "Improvements in brazing electrically, such improvements being particularly applicable to the frames of velocipedes." P. L. RENOUF. Dated May 14th.

8,258. "Improvements in the construction of electrical vent sealing tubes for firing ordnance, and for like purposes." H. C. L. HOLDEN. Dated May 14th. (*Complete.*)

8,272. "Electro-magnetic inductography, and the electric transmission of light images or telephotography." J. C. RICHARDSON. Dated May 14th.

8,323. "Improvements in thermo-electric apparatus." J. GOLDSMID. (Communicated by V. Riatti, Italy.) Dated May 14th.

8,349. "Improvements in galleries or holders for holding globes or shades of electric and other lamps." E. WHITEHEAD. Dated May 15th.

8,363. "Testing sight for astigmatism by means of an electric worked card or disc." C. KAHN and W. DANGERFIELD. Dated May 15th.

8,383. "Apparatus for automatically actuating telephones on insertion of coin in payment for the use of same." F. MULLER and W. GENEST. Dated May 15th.

8,386. "Improvements in microphonic or telephonic transmitters." A. T. COLLIER. Dated May 15th.

8,390. "Improved electrical apparatus for signalling the approach and departure of railway trains." S. TAKASHIMA. Dated May 15th.

3,897. "Improvements in methods of automatically regulating alternating current dynamo generators." W. F. TAYLOR. Dated May 15th.

8,401. "Improvements relating to electro-photography and to electro-photographic apparatus, applicable also to the preparation of printing surfaces." C. N. STANILAND and C. J. STANILAND. Dated May 15th.

8,412. "Improvements in the armatures of dynamo-electric machines." W. C. JOHNSON and S. E. PHILLIPS. Dated May 15th.

8,413. "Improved means of regulating the preparation of illuminants for incandescent electric lamps." J. CLEGG. Dated May 15th.

8,457. "Improvements in electric arc lamps." G. A. SPOKES. Dated May 16th.

8,492. "A new system of electromotors, called "Electro-fermmotors Perlovsky." V. PERLOVSKY. Dated May 16th.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1890.

13,410. "Improvements relating to electric semaphores for railways." F. STITZEL, C. WEINEDEL, J. H. EGELHOFF, M. SCHWARTZ, A. REUTLINGER and J. KRIEGER. Dated August 26th. 8d. The object of this invention is to produce a simple and efficient system of electrical circuits for electric railroad signals, by means of which the signals at opposite ends of a block will be simultaneously set to indicate different signals when a train enters a block from either direction. 4 claims.

13,904. "Improvements in and relating to electric railways." M. W. DEWEY. Dated September 4th. 8d. Consists, collectively, in providing a railway, with a working conductor arranged along the railway, a travelling vehicle, an electric motor to propel said vehicle, a current collector extending from the vehicle to the conductor, an electric connection between said motor and collector, two electric signal devices and a plurality of circuit makers and breakers in series in said electric connection and distributed through the interior of the vehicle, a shunt including a resistance around said signal devices, means for automatically varying said resistance to maintain a uniform flow of current through the signal devices independent of the current flowing through the motor, and suitable means for preventing the operation of each of said signal devices when desired without short-circuiting the same. 12 claims.

16,534. "New or improved electrical primers and electrical frictional primers." A. LONGSDON. (A communication from the firm of F. Krupp, of Essen.) Dated October 17th. 6d. Relates to electrical priming screw plugs for discharging ordnance, establishing at the same time a perfect tightening against the backward escape of the powder gases. 2 claims.

16,570. "Improvements in electric motors." H. GROSWITH. Dated October 18th. 6d. Relates to certain improvements in carrying off and utilising the induced currents generated in electric motors, whereby the deleterious effects of such currents are not only avoided, but they are employed or used as an auxiliary means for energising the field magnets of the motor. It also relates to improvements in reversing mechanism for electric motors whereby the direction of rotation of the armature may be changed when desired. 3 claims.

18,034. "An improved electric switch." G. F. REDFERN. (A communication from abroad by A. Schirner, of Berlin.) Dated November 8th. 6d. According to this invention a switch key is employed which is provided with inclined sliding surfaces between or at both sides of the contacts, whereby on the switching key being turned the current is instantaneously switched on or off, without the employment of special springs being necessary, and at the same time the contact surfaces are cleaned. 2 claims.

18,186. "Improvements in electrical measuring instruments." H. H. LAKE. (Communicated from abroad by E. Weston, of America). Dated November 11th. 8d. Consists substantially in a horizontal coil within which a vibrating coil is pivoted. To the pivots of vibrating coil are connected spiral springs, and the vibrating coil and fixed coil are connected in circuit. When a current is established between the terminals of the instrument, the vibrating coil assumes a position having a relation to the pressure or strength of the current, and this position is shown by a needle connected to said vibrating coil, which moves over a suitable scale. The improvements applied to the aforesaid instrument consist first, in a device for controlling the movement of the index needle so that it will move slowly up to its indication and stay there without any violent contact with its stops or undue oscillation; second, in a device for retarding or dampening the motion of the index or pointer, so that the said index, instead of being thrown rapidly to its marking and then caused to oscillate on the establishment of the current, will move gradually to the point indicated and there come to rest; this device operating through the medium of a friction brake; and third, a device for maintaining constant electrical resistance in the circuit of the instrument, despite changes of temperature occurring in said circuit. 3 claims.

18,247. "Improvements in fittings for electric lamps and their conductors." J. D. F. Andrews. Dated November 12th. 6d. Relates to means of readily connecting and disconnecting the parts of electric lamps and their conductors without requiring skill on the part of the operator. 7 claims.

19,744. "Improvements in and relating to electric belts and similar appliances." C. B. Harness. Dated December 3rd. 6d. Comprises an improved method of arranging the plates or generators —and electrically connecting the same, and an improved method of securing the said plates or generators to the belt or similar appliance. The said invention also comprises an improved terminal for facilitating the connection of the belt or similar appliance with the conductors from a battery. 5 claims.

21,026. "Improvements in electrical attachments for railway switches or points, applicable for ringing an audible signal on the locomotive of a train which is approaching a switch which has been misplaced." A. W. Berne and C. A. Fish. Dated December 24th. 6d. The objects of the invention are to ring a bell in the cab of a locomotive when a train is approaching a switch which has been misplaced, thereby warning the engineer, and enabling him to stop the train, and avoid danger. 5 claims.

18,491. "Improvements in dynamo-electric machines." Rankin Kennedy. Dated November 17th. 8d. According to the invention currents are produced without the use or intervention of any commutators or sliding contacts between the exciter and the field magnet circuits, and also without the use or intervention of any commutator or sliding contacts between the generating circuits of the dynamo-electric machine and the external circuits. The object is effected by combining a magneto-electric generator with a dynamo-electric generator, the magneto-electric generator has permanent steel field magnets and its armature is of drum, ring or disc form, as used in Gramme, Siemens, or Schucket dynamos and wound with coils in sections not connected together. 3 claims.

18,638. "Improvements in electricity meters." E. Hartmann and W. Braun. Dated November 18th. 8d. According to this invention the quantity of electricity passing in a conductor is measured and registered by employing an Ampère meter worked by a solenoid having a core of special construction, and causing the amount of deflection of the pointer of this meter to produce a corresponding movement of a registering apparatus by means of an electrically operated device, such as an electro-magnet, which, at given intervals of time, moves the pointer of the Ampère meter back to zero. This movement being transmitted to the registering mechanism, produces an intermittent motion of the latter, corresponding in extent to the amplitude of the deflection or vibration of the pointer of the Ampère meter. The electro-magnet or the like is excited or caused to act on the pointer at the proper times by means of clockwork, which is automatically wound up by the movement of the armature, which intermittently produces the return of the Ampère indicator to zero. 4 claims.

THE PARIS ELECTRIC METER COMPETITION.

It will be remembered that the results of the first competition in electrical energy meters, instituted at Paris in 1889, were far from satisfactory, and that only 7,000 francs could be distributed in prizes out of the 20,000 francs which the Municipal Council placed at the disposal of the committee appointed to award the prizes. At the suggestion of this committee a second competition was instituted, for which the following programme was arranged :—

Competition for the Construction of Electrical Energy Meters.

Programme.

Article 1.—A competition is opened for all inventors of electrical meters applicable to continuous currents alone, to alternating currents alone, or to both forms of current simultaneously.

Article 2.—The instruments submitted may be either electricity meters (*ampère-hours meters*), or energy meters (*watt-hours meters*).

Article 3.—The meter must be of such a nature that it can be read directly, and that the consumer can see for himself the quantity consumed.

Article 4.—The meters must be adapted to consumption on a small scale; the electricity meters must register from two-tenths of an ampère, the energy meters from 20 watts.

Article 5.—The meters, accompanied by an explanatory notice, must be delivered, sealed, at the Municipal Works at the Halles, between the 25th and 31st August, 1890. A receipt will be sent in due course.

Article 6.—The meters sent will be submitted to the decision of a committee composed of nine members, five being appointed by the Municipal Council, and four by the State.

Article 7.—The instruments will be subjected to comparative experiments bearing upon :

(*a*) Their accuracy throughout the scale of indications of which they are capable.

(*b*) Their practical value (as regards regularity of action, simplicity, cost, &c.).

(*c*) The energy expended in working them.

(*d*) The extent to which the distribution of the current is affected by their employment.

Article 8.—A sum of 13,000 francs will be distributed in prizes under the following conditions :—10,000 francs to the inventor who shall produce a meter giving complete satisfaction, and applicable to alternating currents as well as continuous currents.

If the meter should be applicable to one form of current only, the inventor will only be entitled to half the amount.

Prizes amounting to 2,000 francs for meters that can be applied to both alternating and continuous currents, and to 1,000 francs for meters applicable to one form only, will be awarded to those inventors whose apparatus show important progress in this branch of electricity.

The committee appointed on the 9th December, 1890 with M. Huet, Sub-Director of Public Works for the city of Paris, as president, assembled for the first time on December 11th, and at once commenced the experiments, which proceeded almost without interruption until May 15th, under the superintendence of a sub-committee composed of Messrs. Carpentier, Hospitalier, Mascart, and Potier. At a final meeting held on May 30th, 1891, the committee gave their unanimous approval to the decisions of the sub-committee, appointed M. Hospitalier reporter, and passed the following resolutions :—

"The committee appointed to decide between the electrical energy meters entering into the competition, opened at the Hôtel de Ville, is of opinion :

"That the Aron and Thomson meters fulfil all the conditions laid down in the second paragraph of Article 8 of the programme of the competition, and proposes to divide between them the prize of 10,000 francs to be awarded to the inventor who shall produce a meter giving complete satisfaction, and applicable to both alternating and continuous currents.

"The committee is of opinion that the instruments submitted by M. Frager and M. Marès show important progress, and propose to award three prizes of 1,000 francs each to these apparatus, as follows :—M. Frager, 1,000 francs (alternating currents); M. Frager, 1,000 francs (continuous currents); M. Marès, 1,000 francs (continuous currents); in accordance with the fourth paragraph of Article 8."

The decision of the committee will be inserted in the *Bulletin Municipal Officiel*.

CORRESPONDENCE.

Jablochkoff Electric Lighting Patent.

I have noticed the article in your last issue on the subject of the petitions of the Electrical Engineering Corporation for the confirmation and extension of Jablochkoff's patent of May 22nd, 1877, and I must take exception to the reflections made therein upon the very able legal advisers of the Corporation in this matter.

Your informant appears to have entirely misled you as to the nature of Lord Watson's judgment, and I am sure that you will feel anxious to acknowledge an error that you have inadvertently fallen into involving the reputation of others.

The unfortunate necessity for a petition for a confirmation of the patent was not apprehended until the day before the date fixed for the hearing of the petition for extension, it being only then that the publication of the patent in a communication made to the Society of Telegraph Engineers was discovered. It is phenomenal that the patent having been brought forward in important law suits, having been prominently before the public for so great a length of time, numbers of licences having been granted and large sums paid under them with a certainty in each case of any importance that due investigation of the merits of the patent was made, this prior publication should not have been discovered until the patent had lived almost its 14 years. The technical point, however, on which the hearing of the petitions was not proceeded with, was a new one and had never been settled in a court before the second hearing of the petitions. It had been held by council and by patent agents that when the Act of 1883 came into existence, patents taken out under the old Act of 1852 by foreigners were relieved from the very considerable disadvantage existing under the old Act, that had any foreign patent been taken out anterior to the British patent, and that foreign patent allowed to lapse, the British patent would terminate at the same time, notwithstanding that its 14 years had not lapsed; but on the contrary, it was held that the old patents obtained the advantages of the new Act when it came into existence and would, therefore, live independently of lapsing of foreign patents. The Belgium Jablochkoff patent had been allowed to lapse by its owners in 1888 and the judgment of the Judicial Committee of the Privy Council was to the effect that, therefore, the English patent lapsed on the same date, and that the patent was therefore dead and at an end for all purposes in 1888. Doubtless this decision will affect many valuable English patents taken out by foreigners and having anterior foreign patents, some of which have been allowed to expire, and it is now undoubtedly a matter of great importance to the holders of such English patents taken out under the old Act to see that the foreign patents, if anterior to the English one, be not allowed to lapse.

You will see, sir, that this is a very different thing to the construction you have placed upon it, and when I point out that the counsel for the Corporation were Messrs. Moulton, Q.C., and R. W. Wallace, the solicitors, Messrs. Fathfull and Owen, and the patent agents, Messrs. Abel and Imray, you will doubtless recognise that as far as previous knowledge went, it was impossible that these gentlemen, than whom none have greater experience in the procedure for the prolongation of patents as understood up to this present case, should make a mistake of the kind you attribute to them, and, indeed, in that case you must include in your count the Attorney-General himself, who up to and after the first hearing of the petition had not thus construed the effects of the Act of 1883 on that of 1852, although at the second hearing he advanced the proposition, and successfully, before the Privy Council.

E. Manville.

May 27th, 1891.

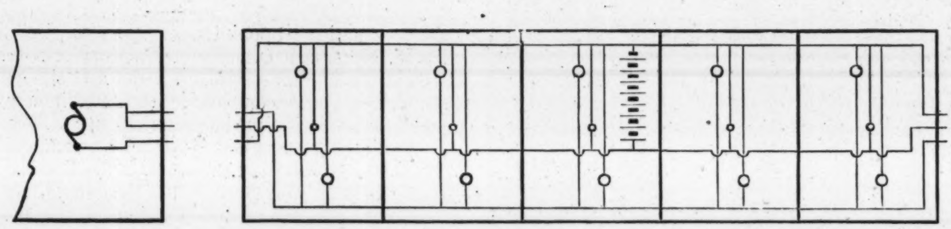
Railway Train Lighting.

Referring to the article on this subject in your last issue, I am surprised at seeing no mention made of the guard's van as the location of the generating plant. Surely, what with regulators, reversing levers, steam blasts, sand boxes, firing, air pumps, steam and air brakes, gauges, gauge cocks, whistles and roadside signals, &c., engine drivers and firemen have enough on their hands at present!

But it appears to me that for other reasons the guard's van is to be preferred for carrying the lighting machinery. In the first place it affords complete protection from the weather and from coal dust, without inconvenient boxing in, and the whole apparatus is always accessible, even when the train is in motion. Then the running of the van is much easier than that of the locomotive, and will not put such violent strains on shafts and bearings. An advantage to the guard in cold weather is that the engine will keep the van comfortably warm.

Coming now to the question of what kind of motive power to adopt, it is evident that a steam engine and boiler would be quite out of place, besides occupying too much of the guard's time. A gas engine would do; but, all things considered, a petroleum engine seems the best adapted for this special purpose. Many of these engines have now been at work for a considerable time, and, according to all accounts, are giving great satisfaction. Compared with high pressure steam engines they are, of course, bulky and heavy, but it is only reasonable to suppose that, by means of steel, and perhaps aluminium bronze, a large reduction of weight could be effected.

To economise in accumulators, some such arrangement as shown in the sketch may be used. The main lights being run direct by the dynamo, one small accumulator in each coach is all that would be required to supply what, for distinction, may be called the shunting lamps. Thus, suppose each compartment to contain two 8-C.P. lamps and one of 4-C.P. (the last only being in the accumulator circuit), all three lamps will be running under ordinary circumstances, but, whenever a carriage is disconnected from the guard's van, only the 4-C.P. or shunting lamp continues in action. As the time when a carriage containing passengers requires to be left by itself is very short, this diminished light is sufficient for all practical purposes, and, as the accumulator need never be run down far, it can always be charged under the constant P.D. of the main leads, and its life should be a long one.



Probably this matter has been fully dealt with in Mr. Langdon's paper; but I have had no opportunity of learning if this is so.

Wilfrid S. Boult.

June 1st, 1891.

Some Researches in Electro-Magnetic Induction.

May I be permitted to make a few remarks with regard to the paper by Mr. Vignoles which appeared in your last number. It is not correct to say that the name of *Gauss* has been given to the unit C.G.S. of magnetic induction by the International Congress of Electricians, held at Paris. A proposal of this nature was certainly made, but like many others, alas! it fell through without being discussed, the greater number of influential *savants* at the Congress not appreciating the practical importance of giving new names to new notions and new units. The congress is not therefore responsible for the coinage of "Gauss," and the "Thom" has not yet formally crossed the Channel, although the compliment thus paid to Sir William Thomson can only be received enthusiastically by the first International Congress. We willingly accept then the "Thom" and the "Gauss," but we strongly object to the measurement of H in dynes, as

Mr. Vignoles has it. The intensity of the magnetic field is not a force, but rather the quotient of a force by a polar intensity, $F = m H$; it is therefore absolutely incorrect to measure it by dynes. We can only measure by dynes physical quantities having the same dimensions as the force; and this is not the case with the intensity of the magnetic field. It is high time for some scientist of undisputed authority to oppose this irregular and inaccurate coinage of new words, often selected at random, without any consideration of the physical quantities to be defined and measured. We quoted recently an instance of this with regard to specific resistance which should be measured by centimetre-ohms and not by ohms per cubic centimetre. We now have a fresh instance in the case of the intensity of the magnetic field, which Mr. Vignoles proposes to measure by dynes. At this rate electrical terminology will become in twenty years hopelessly confused and incomprehensible, to the great detriment of electrical science.

C. G. S.

Elmore's Companies.

Herewith I send you printed copy of a letter which I have written in reply to Mr. Alexander Watt's comments in the *Engineering and Mining Journal* of New York, with my views as to its editorials.

I need scarcely say that I stand by all the statements made, as they are the result of personal investigation.

W. J. Peck.

Metropolitan and Provincial Syndicate, Ltd.,
Lonsdale Chambers, 27, Chancery Lane,
London, W.C., *May 29th*, 1891.

[We regret that this somewhat maladroitly-headed letter is much too long to enable us to publish it in full, but we give as fully as possible the reply of Mr. Peck on that part of Mr. Watt's criticisms which has appeared in our columns, viz., the letter which we quoted from the *Financial Times* in our issue of April 10th, on the foliated character of the deposit.

We have numbered the paragraphs for convenience of comments which will be found at foot.]

Copy of a letter forwarded to the "Engineering and Mining Journal," *of New York, for publication in reply to a letter of* Mr. Alexander Watt, *of April 18th*, 1891.

THE ELMORE COPPER DEPOSITING COMPANY'S SCHEMES.

Sir,—(1) I notice in your issue of April 18th last that a letter from one Alexander Watt is published *re* the Elmore depositing process. Before dealing with your editorials, I should like to go seriatim through Mr. Watt's letter, and give your readers my views on it, then to deal with Mr. Watt himself, and finally with your remarks. Mr. Watt says that "the opinion of those who understand the electro-deposition of metals thoroughly seems to be of an adverse character." This I most emphatically denounce as a deliberate misstatement. I say "deliberate," and use such a strong form of expression because I cannot believe that Mr. Watt has written the letter he has, without consulting the prospectus of the Elmore Company, and the copies of reports attached thereto, and for the sake of proving my point, I beg to refer you to the following extracts from some of them.

[Extracts are given from reports of the authorities mentioned in the next paragraph, and Dr. Hopkinson's report, dated September 25th, 1890, is given in full.]

(2) Now, I think I have quoted sufficient to show that when Mr. Watt states that people capable of judging give an adverse opinion on the Elmore process, he is stating that which is not a fact. I leave your readers to judge whether or not such men as Dr. Hopkinson, Mr. Preece, and Mr. J. T. Sprague are not sufficient to support the electrical side of the question, and such men as Mr. John, Mr. Massey, Dr. Hopkinson, and Profs. Kennedy and Unwin the mechanical side; and I ask whether it does not appear a piece of great presumption on the part of Mr. Watt to dare to create himself the judge of such men. Surely, after having these names brought before him, Mr. Watt will not again attempt to refer to them as "persons unacquainted with the electro-deposition of metals."

(3) One very extraordinary thing then becomes apparent in Mr. Watt's letter, and is worthy of especial note by your readers. He says, "*And it may ultimately be found*—as I believe it will be found—that a tube formed by the Elmore method will, when subjected to the necessary heat of a boiler, gradually give way." It is to the two words "*may ultimately*" that I particularly direct your attention, because in the *Financial Times* of London, on April 4th, Mr. Watt published a letter (of which the one now under criticism is a kind of *réchauffe*) in which he made the *definite* statement that an Elmore tube *would* give way when exposed to "even a moderate degree of heat." There was no saving clause of any kind; he unfortunately left himself no loophole by which to escape. There was no "may ultimately be found," or "as I believe it will be found;" he made the distinct statement that it *was* so. Now, it is only reasonable to suppose that there is some cause for this sudden assumption of modesty by Mr. Watt; perhaps he will explain why he is so emphatic in one letter, and in another so very weak and vacillating.

(4) Probably you are not aware that Mr. Wm. Elmore—who is the father of the inventors and the managing director of the company—challenged Mr. Watt to prove what he had stated. A copy of Mr. Elmore's letter which appeared in the *Financial Times* of April 28th last, is as follows:—

[This letter proposes the settlement of the controversy by a wager, and is identical with that addressed to us, and appearing in our issue of May 1st.]

(5) When Mr. Watt is thus driven into a corner he makes no reply to Mr. Elmore, does not produce his proofs, and cannot inspire sufficient confidence in anyone who publishes his letters, adopts his views, and writes complimentary editorials regarding him, to find the money to put him in a position to accept the challenge and back his opinion in a manly and substantial way.

(6) Mr. Watt then tells us that "metals deposited by electrolysis do not adhere well, if at all, to their kind." This is news indeed. I do not profess to know much about the subject, but can truthfully say that I have seen solid electro-deposits of $\frac{3}{4}$-inch and more in thickness; and it would appear that if Mr. Watt's contentions were right, this would be an utter impossibility, because, if the particles of metal had no cohesion, or did not adhere well together, the plate could not exist as a plate and would fall to pieces. Mr. Watt's statement that by a momentary stoppage caused by a trifling repair or otherwise, the metal thereafter deposited becomes a distinctly separate layer, I know is not the fact, and his statement that the burnisher "aids in loosening or stripping" this superposed layer from the first layer, only proves to anyone having the bare outlines of the Elmore process in his head, how little Mr. Watt knows of the subject upon which he presumes to write. By using this expression Mr. Watt evidently assumes that the burnisher has the effect of extending the copper, and so making it loose on the underlying metal. Now, it is well known that after the tube is formed by the Elmore process on the iron mandrel, that for the purpose of separating the tube from its mandrel, the tube is squeezed in the rolling machine, which was illustrated in one of your previous issues. This squeezing has the effect of slightly extending the copper tube on the mandrel, and so allowing it to be readily separated. This one fact alone plainly proves to my mind that the burnisher has absolutely no action in "loosening or stripping [the copper] from the underlying surface." Because, if so, there would be no necessity to submit the tube and mandrel to the action of the rolling machine for the purpose of separating them. . . . . Mr. Watt goes on to say that he has "proved in a hundred ways" that deposited metals will not adhere to polished or burnished surfaces. Mr. Watt may have satisfied *himself* on this point, but I am afraid not your readers, as I am sure his mere statement that *he* is satisfied after I have discovered so many wrongly-judged points in his letter would not be a convincing argument to me. If deposited metal will not adhere to bright surfaces, it is a waste of time for the Electrotyping Department of the Ordnance Survey to take the elaborate precautions they do by means of iodising, &c., to prevent this very thing that Mr. Watt says he has "proved in a hundred ways" cannot take place. To take a charitable view, I will content myself by assuming that Mr. Watt has never heard of Mr. A. Smee's theory as to the cause of deposited metals not attaching themselves to the underlying metal.

(7) It is to be borne in mind that none of these foreign works were put in hand—not a brick laid, not a hand moved—till after the most capable engineers that the directors of the foreign companies could find had been to the parent company's works at Leeds, and thoroughly studied the process in operation. I do not mean that these gentlemen went to the works for an hour or so, but that they stayed there for weeks together, and when they had thoroughly investigated every detail of the process, reported to their directors that they were more than satisfied with what they had seen. These were men who have been at the heads of some of the largest works on the Continent; men who were not only capable of judging as to the soundness of the scientific principles underlaying the process, but also as to the possibility of working on a commercial scale.

(8) Mr. Watt makes the statement that "Elmore originally professed to produce his copper tubes from *rough copper or matte*." If it is suggested that this statement appeared in the prospectus, I again have to contradict Mr. Watt. The statement in the prospectus is quite clear to anyone, and is as follows:—"By the process of Messrs. F. E. and A. S. Elmore, copper is electrically deposited from the *rough bars*." And again: "For manufacturing copper articles direct from the *rough copper bars*." Here is another of the points upon which Mr. Watt has erred. It is a well-known fact that the Elmores are using Chili bars. There is no secret in all this, as a pile of 200 tons of "Lota" bars was shown to the representatives of the Press on the occasion of their recent visit to the Elmore works.

(9) I think I have now dealt with all the points in Mr. Watt's letter, and would say that before the slightest heed is given to Mr. Watt's remarks, your readers should satisfy themselves as to his capacity to criticise the Elmore process, as to his knowledge of that process, and as to his *bonâ fides*.

I am, yours, &c.,

William J. Peck, F.S.Sc.

National Liberal Club,
London, *May 21st*, 1891.

[1 & 2. Might not Mr. Peck have said "for the sake of giving these reports further currency at this time?" For the practical purpose of considering the commercial prospects of Elmore companies these reports on abstract questions of electro-deposition are out of date; so far as they relate to the different results obtained by the Elmore system over other systems they are, of course, to the point, but in these respects, too, they must be relegated to obscurity. An ounce of practical commercial work is worth a pound of scientific report.

(3) We must congratulate Mr. Peck on the very able way in which he makes clear what Mr. Watt did say. We fear that we shall be considered somewhat profane, but we are irresistibly reminded of an eminent discourse on the text of Mother Hubbard, who "did not hop, or skip, or jump, but *went* to the cupboard." What does it matter, Mr. Peck? We did not understand Mr. Watt to say that he had tested a tube and that it exfoliated, but that for certain given reasons it might, could, should, or would exfoliate.

5. We published Mr. Watt's letters; we did not "adopt his views," but we said they were "entitled to consideration," which we suppose is near enough, and may also be turned into "complimentary editorials," and Mr. Peck would probably tell us that if the cap fits we may wear it. We will. Our opinion of Mr. Elmore's letter was given at the time it appeared. We gather that Mr. Peck thinks it "manly" on Mr. Elmore's part to "challenge" Mr. Watt to a wager for an amount which he thinks it may be necessary for some "champion" to provide, and not unmanly on Mr. Peck's part to assume that if the challenge is not accepted there can be no other reason than that Mr. Watt "cannot inspire sufficient confidence in any one to find the money to put him in the position to accept the challenge." For a man who uses the word "manly" Mr. Peck should have stated that one who published the letters declined to permit Mr. Watt to make any reply. The fact and the reason are plainly stated in our note to Mr. Elmore's undignified proposal. We hope that the company will be able to dissociate itself from the acts of its managing director, and Mr. Peck. Such advocacy is not improving.

6. Perhaps Mr. Peck will resume the controversy when he does know something about the subject.

7. Such as M. Sécretan, whose report to his directors we published on November 28th last.

8. Mr. Peck is splitting hairs to no purpose. He should have italicised the word "direct" also. Mr. Watt is substantially right, and Mr. Peck substantially wrong. The copper bars are first melted and then converted into granules.

9. It is to be regretted that Mr. Peck has omitted to furnish similar information on his own part.—EDS. ELEC. REV.]

On the Relative Cost and Economy of High and Low Pressure Central Stations.

I have read in your number of May 29th Mr. Addenbrooke's criticism on my paper read before the Institution of Electrical Engineers, "On the most economical mode of feeding a network," and am glad of the opportunity of answering it. I must first explain why I brought forward my short paper on this very important subject at such a late period of the session.

It is only within the last few months that there appears to be a consensus of opinion amongst the ablest advocates of high pressure supply on the subject of distribution. They now all appear to admit that their best policy is to use high pressure feeders transformed to low pressure, by transformers placed at the feeding points of a low pressure network. The system formerly advocated of supplying transformers to each of the separate houses involved so many special problems, that it was difficult to compare it accurately with low pressure systems, and it was only after I had worked out the comparative first cost, and cost of upkeep of feeders on the two systems (the high pressure one being modified as above), that I became aware to what extent the cost of upkeep and interest on these feeders affected the cost of electricity distributed by them from stations distant from the district to be supplied. I first had the idea to bring the matter forward in a discussion on Mr. Preece's paper on mains, but my absence on a business journey prevented this, and I was obliged to communicate my views in the form of a paper to be read by the secretary. Put briefly, the position I take up in my paper is that the cost of feeders on either the high or low pressure systems supplying a district from a point exceeding a mile from its centre is so great that it can be very rarely worth while to place the generating station so far out of the centre; but if this has to be done, it can probably be done most efficiently and economically by extreme high pressure transformed at one or two stations only in the district to be supplied, and from thence distributed by low pressure feeders to a low pressure network.

I have carefully looked through Mr. Addenbrooke's criticisms, and I cannot see that they seriously affect my arguments on this question; but taking them in order, I find that he is under a misapprehension in stating that I propose to lose 10 per cent. in the high-pressure feeders. In my paper I stated that the average annual efficiency of the feeders in both cases was 90 per cent. By this I mean that the total loss in the high pressure conductor and in the transformers taken together will be 10 per cent. I adopted this figure because I understand it is the highest efficiency yet obtained in practice at Rome and elsewhere, and that it is not likely to be exceeded. In my comparison I calculated the high pressure cables to have precisely the loss which Mr. Addenbrooke himself admits to be correct, viz., 2½ per cent. This disposes of his next statement that there would be a saving of 7½ per cent. in the energy transmitted through the high tension cable; as I show above, this saving is swept away by the loss in the transformer.

Another point I should have explained if I had been present at the meeting is that raised by Mr. Kapp, when he says that the extra loss in the low pressure mains at times of maximum load will entail a corresponding increase in the capacity of the generating plant. Although this would be the case in a few stations which have an exceedingly good load factor, yet it would not be the case in the one that I am discussing having a load factor of 10. I very much fear that such stations will be the rule and not the exception, and in them we find that the hours of maximum load are very short; indeed, so short, that the extra loss in the low pressure feeders during the time of maximum load can be very easily met by the accumulators which I, and those who work on the same lines as I do, find it necessary to have, in order to prevent our machinery working at night.

In reply to Mr. Addenbrooke's other questions, the reason why I put down the cost of upkeep of the transformer pit at 2½ per cent is, that I think it would be frequently opened and examined, and as transformers hitherto have not been free from being burnt out and other mishaps, the transformer pit itself would suffer from the removal and exchange of transformers. At any rate the sum of 2½ per cent. is a trifling matter, and is not worth discussing. I adhere to my estimate of 10 per cent. being a fair estimate of the cost of upkeep of transformers as made at the present time. It is quite possible that in future the cost may be greatly lowered, but no one who has had experience in the management and upkeep of transformers up to date would dare to put the cost of upkeep at a lower figure.

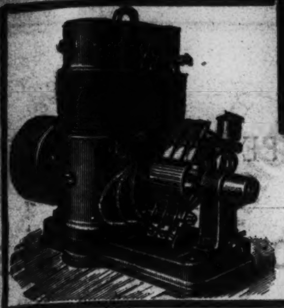
As in the latter portion of his criticism, Mr. Addenbrooke virtually admits that the price I put down for the feeders is a correct one, it appears that apart from the small criticisms I have noticed, and which I point out do not seriously affect the question, he and I are practically in agreement on the point that feeders 2,400 yards long on either system can be put down for the same sum, and that in both cases this sum is a large one, and that the interest and upkeep of it is very considerable, so considerable as to tell very seriously on the cost of the electrical energy.

I think from conversations I have had with Mr. Addenbrooke he will further agree with me when I say that in such cases, when central stations actually within the area to be lighted cannot be obtained, it is far better to transmit the power from extreme distances, so as to make really great savings in the cost of fuel. I know Mr. Addenbrooke believes with me that if the Frankfort transmission experiments are as successful as we all hope they will be, that it will be then easy to show that we may transmit electrical energy to London direct from the nearest coal fields, but in order to do this we must then use the extreme high pressure, of which Mr. Ferranti is the pioneer.

I think also Mr. Addenbrooke will agree with me that little or nothing is gained by moving a central station from a central point to a point only a mile or two outside the district, in order to effect trifling economies in rent and cost of fuel and facilities in obtaining and condensing water.

R. E. Crompton.

June 2nd, 1891.



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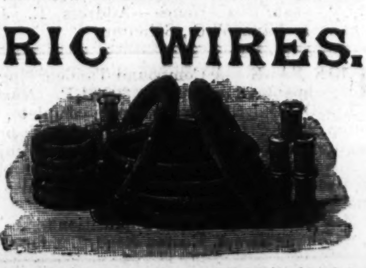

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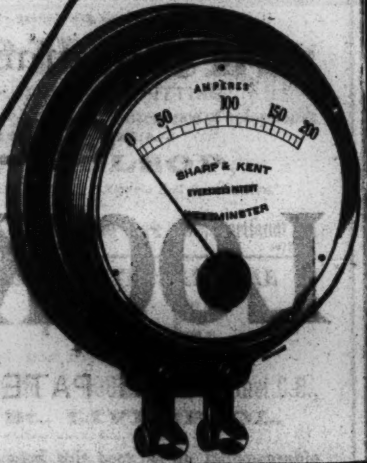

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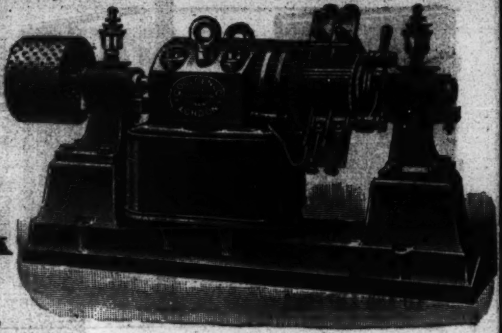

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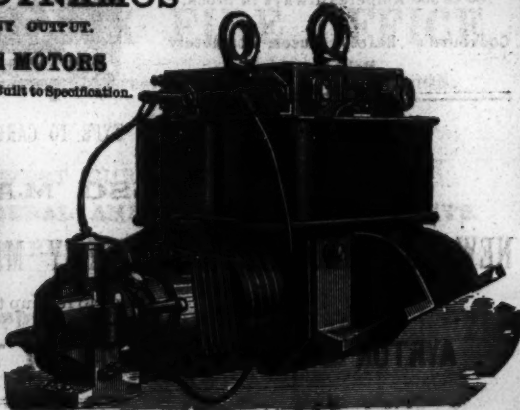

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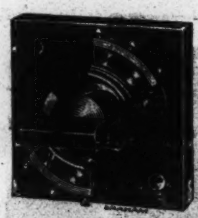

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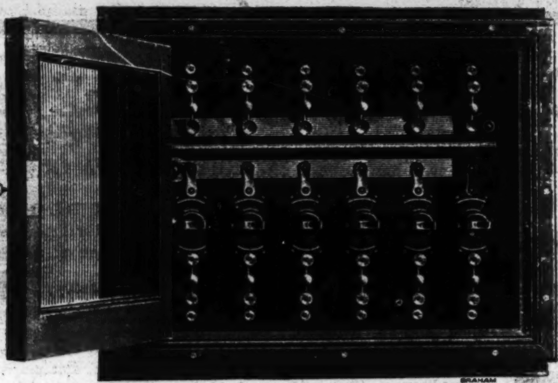

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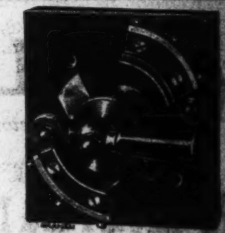

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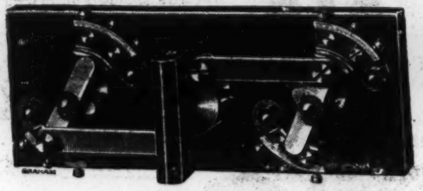

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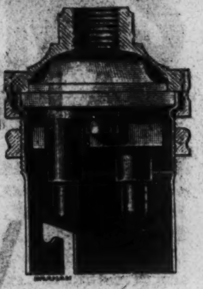

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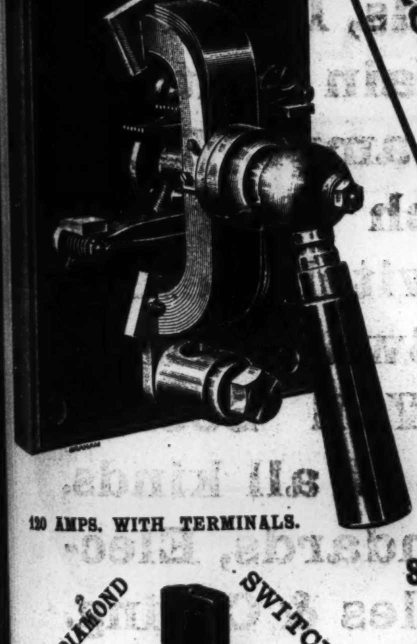

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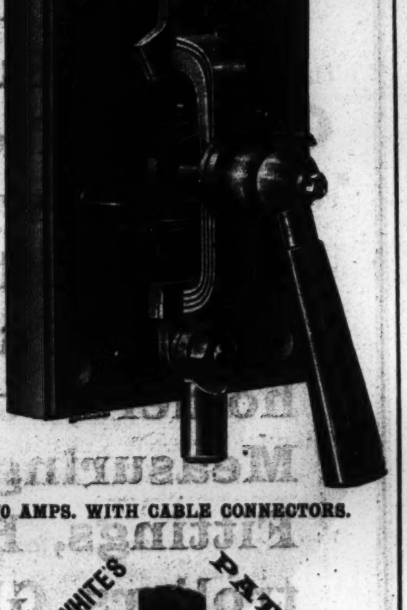

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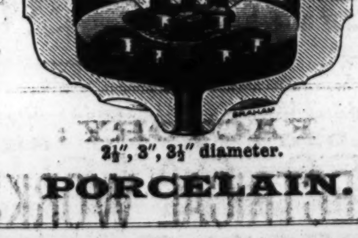

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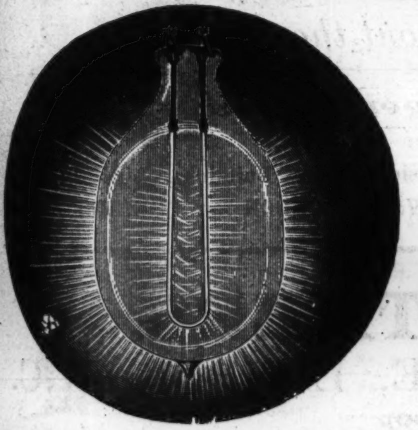

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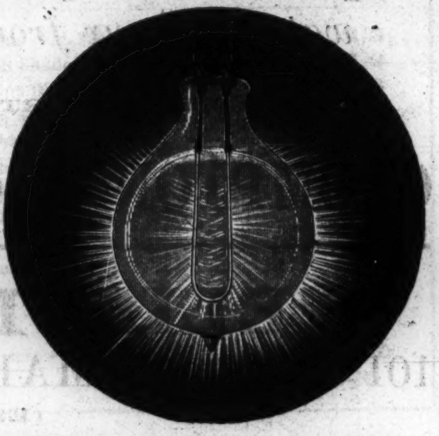

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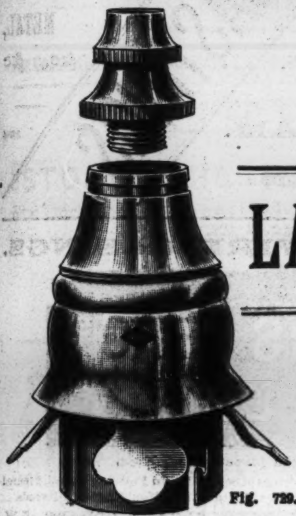


Fig. 729.

LAMP HOLDERS.

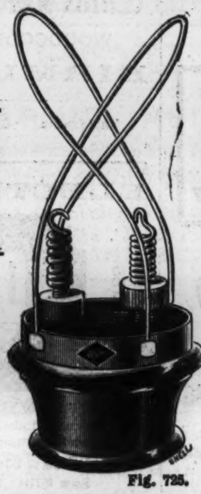
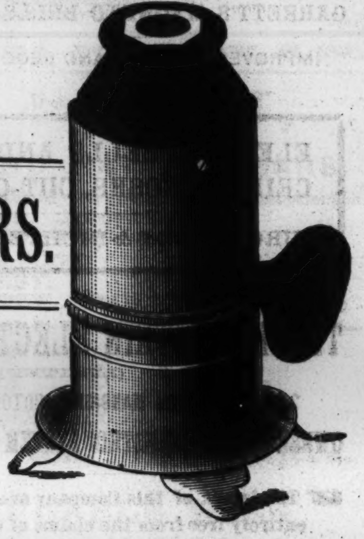


Fig. 725.



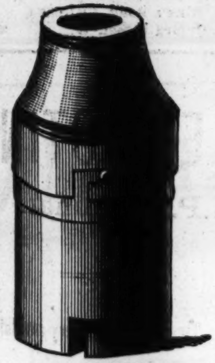


Fig. 727.

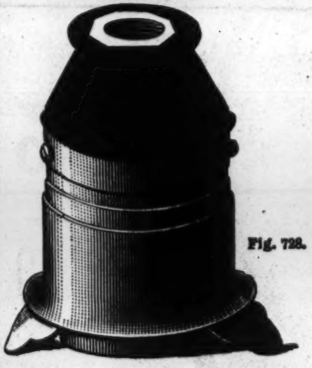


Fig. 728.

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Do. do. do. with Shade Carrier (Fig. 729) ...	1/8
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No. 24.— do. do. do.	1/3
Nozzle for suspension (extra)	-/6
No. 10.—Cap Adapter for Loop Lamps, each	-/9
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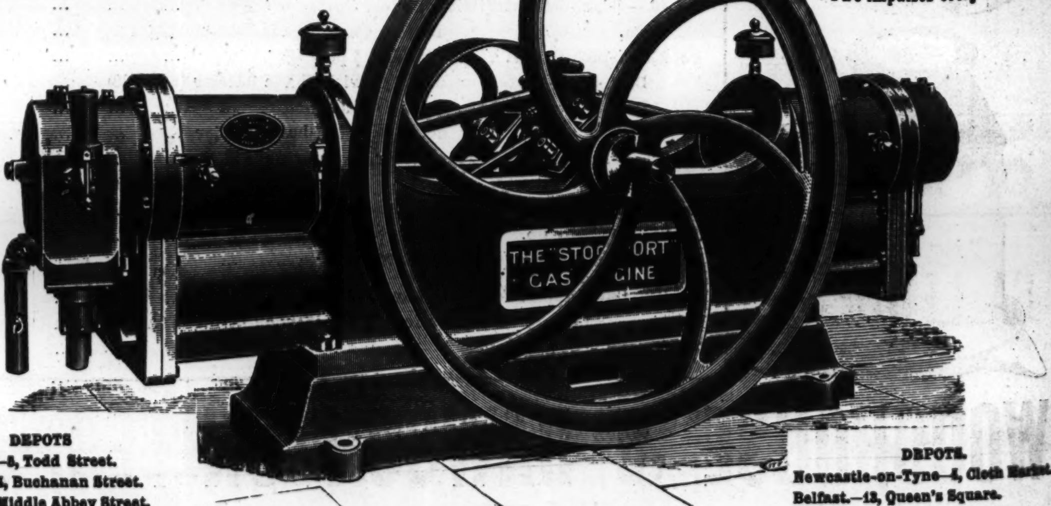

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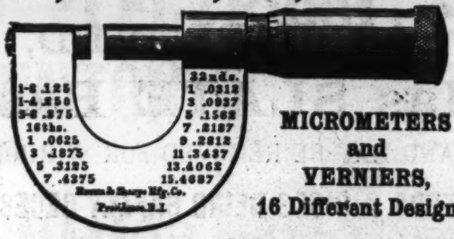

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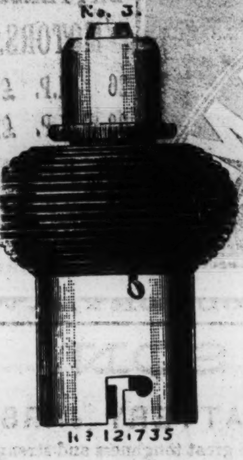

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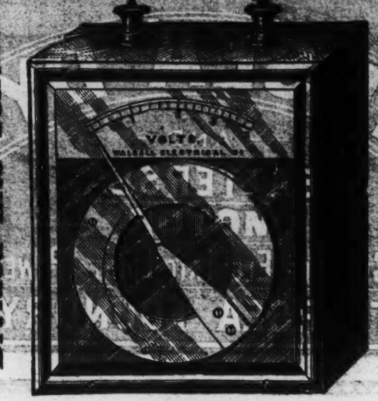

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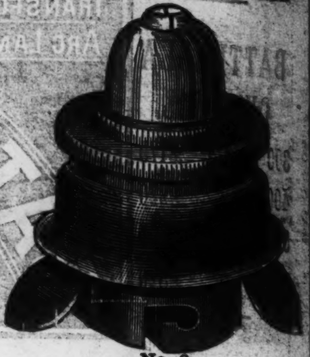

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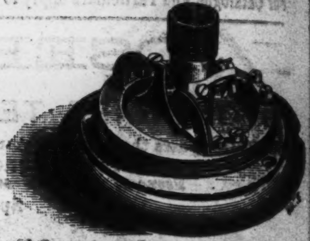

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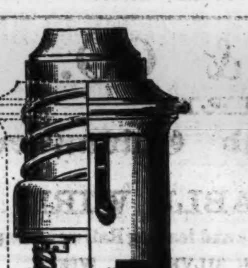

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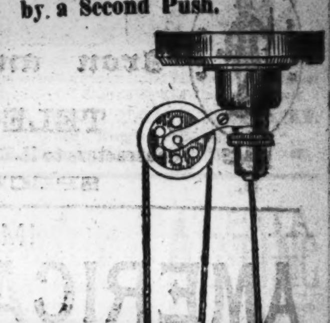

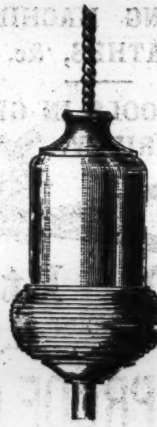

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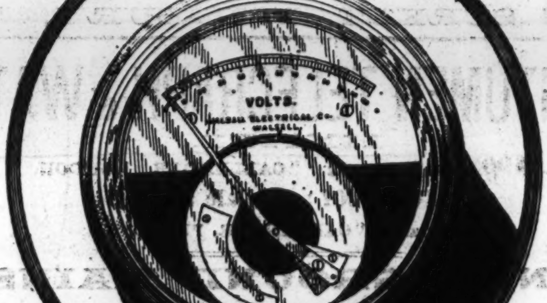

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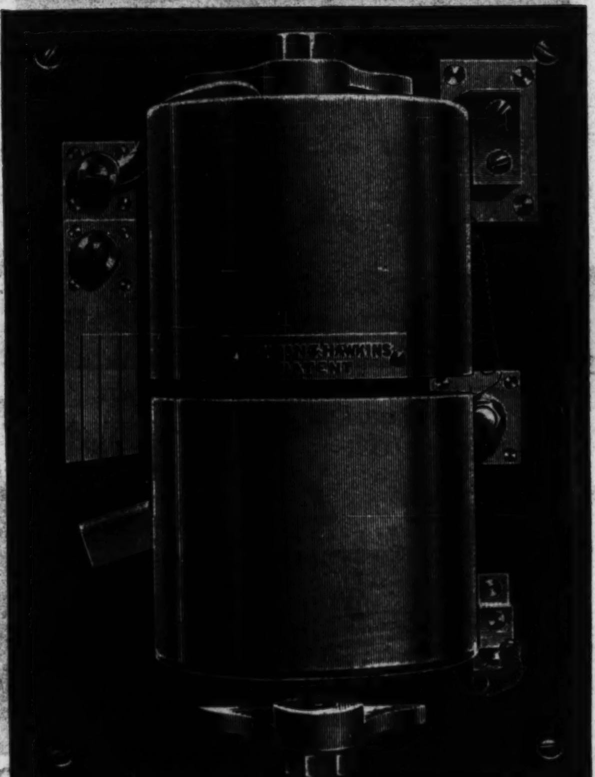

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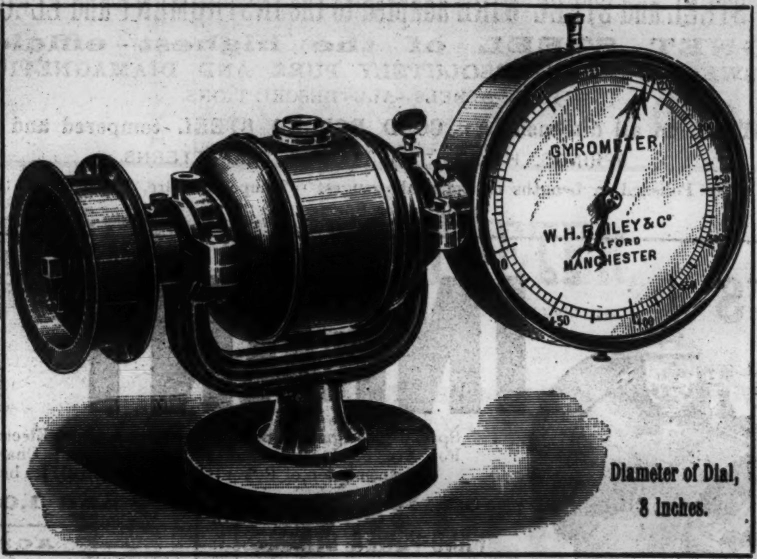

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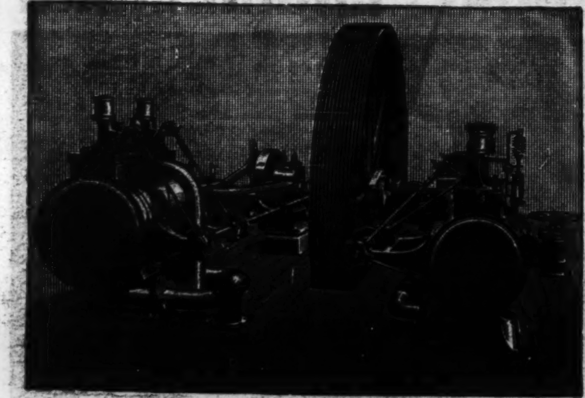

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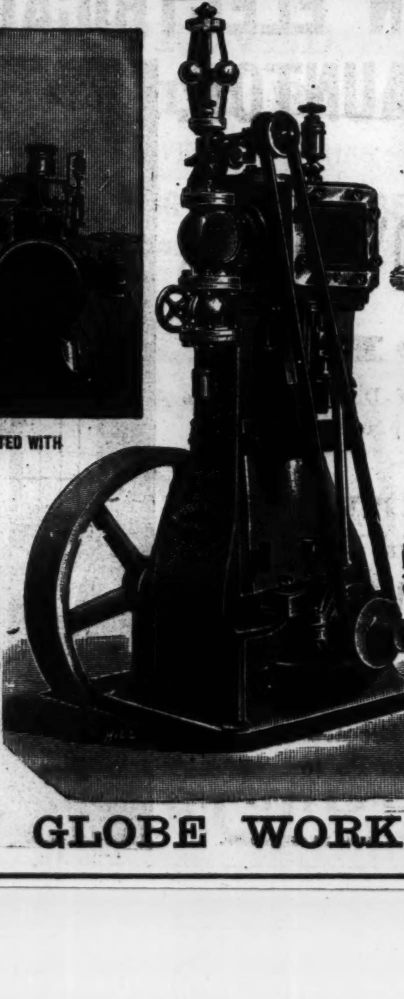

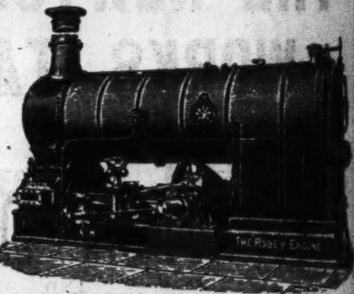

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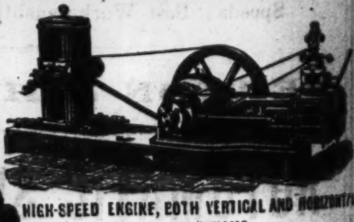

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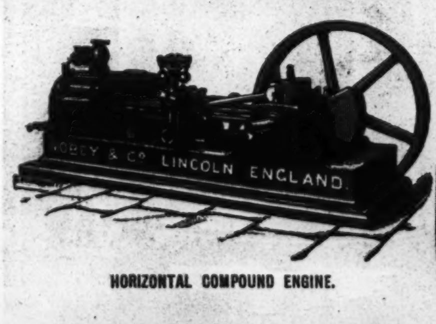

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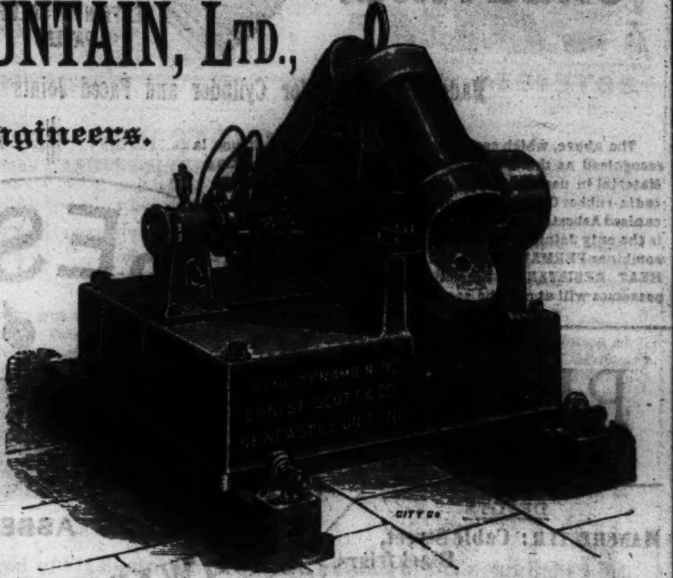

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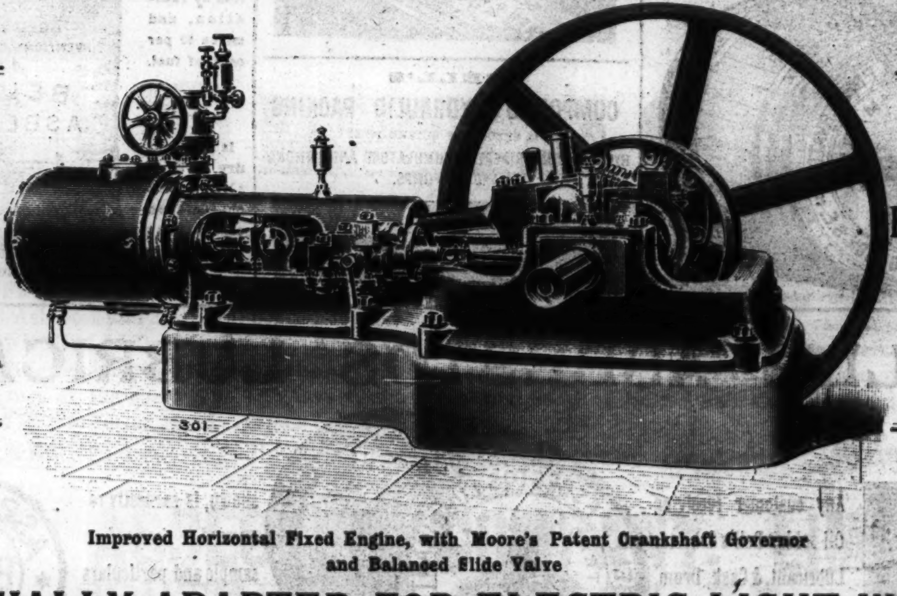

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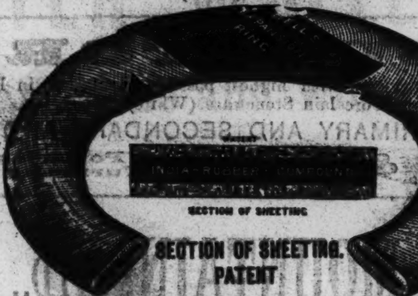

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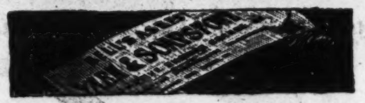

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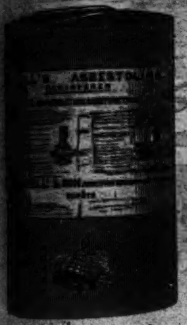

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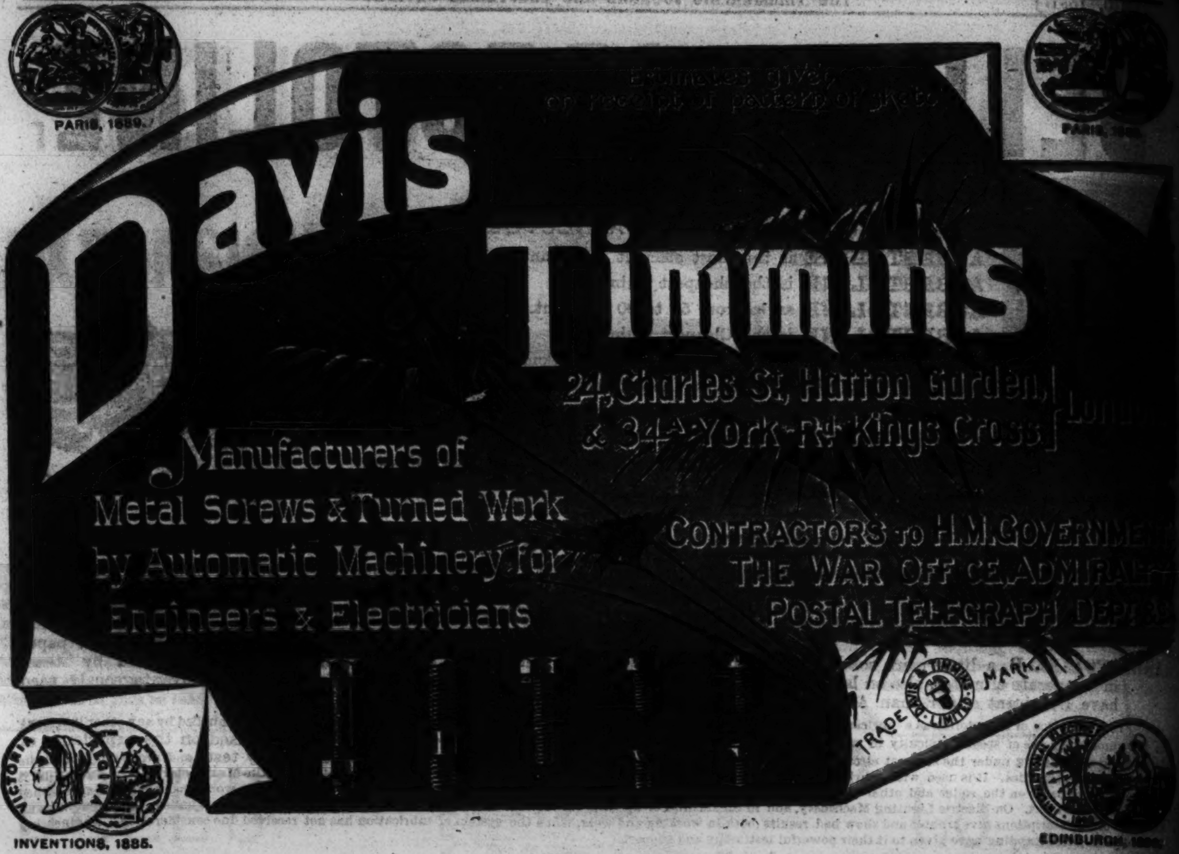
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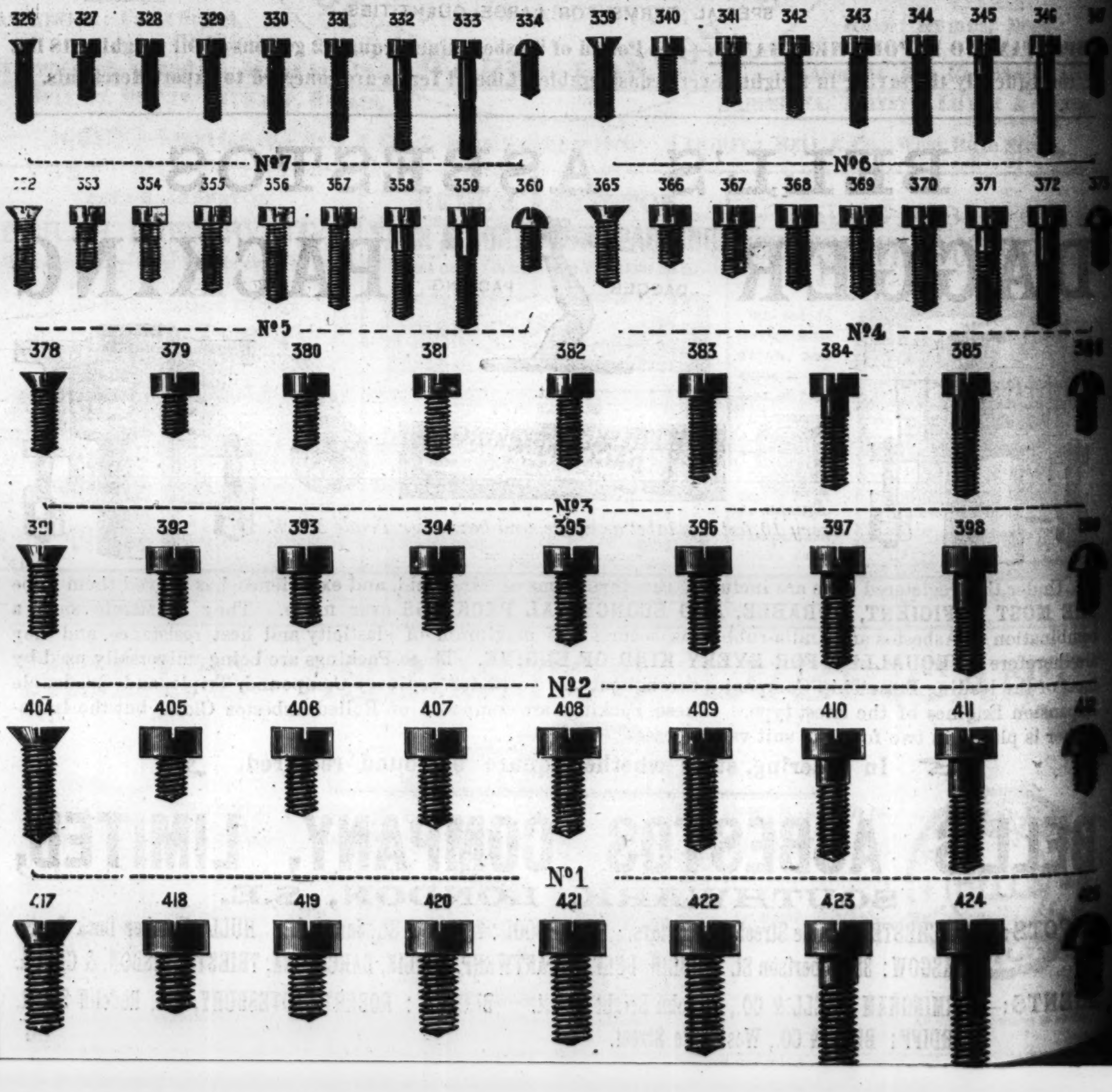

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